CONSIDERATIONS

ON THE

MEDICINAL USE,

AND ON THE

PRODUCTION

OF

FACTITIOUS AIRS.

PART I. By THOMAS BEDDOES, M. D.
PART II. By JAMES WATT, Engineer.

EDITION THE THIRD.

Corrected and Enlarged.

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TO Mr. WATT.

DEAR SIR,

YOU will probably be startled when you read your name on the page destined to dedication; but I cannot prevail upon myself to send these considerations a third time abroad, without acknowledging my satisfaction in having had you for a fellow labourer. To establish a new department in Medicine, would have exceeded my single strength; and I do not know any person who could have afforded me such effectual assistance as you have done.

That the pneumatic practice is beginning to acquire the certainty of a genuine art, may be too bold a thing for me to assert; but if this should prove to be the case, I need not explain how much it is indebted to you for the rapidity of its progress, the means of judging being fully before the public. The zeal, however, with which you exerted your talents to do good, could be witnessed but by a few; and it is particularly incumbent on me to return thanks both to you and Mr. BOULTON, *for so liberally consenting, at my earnest request, to manufacture your air-apparatus. The profits were never likely to requite any man—much less persons engaged in such extensive concerns—for the expence and vexation always occasioned by a new branch of business.*

Though you have succeeded so far as to enable any one, who chooses, to procure elastic fluids with perfect ease, and in the utmost abundance, I hope you will not entirely abandon the subject. By turning your thoughts to it from time to time, you will not fail to help us forward by some useful hint, or happy invention.

Of those members of the medical profession, who have already made trial of factitious airs, the desire of certainty, or the uneasiness of doubt would ensure the perseverance, even though they had met with no direct encouragement. Others will feel it their duty or interest to adopt the same practice. Nor will the sick or their friends be universally quieted by unmeaning objections or overawed by that authoritative tone which ignorance—and medical ignorance, more especially—is so apt to assume. Notwithstanding the times, a much more lively interest has been manifested by the public in this arduous undertaking than I could have expected. And should the pursuit, which I by no means apprehend, be abandoned here, it will be continued in other countries. I could prove by sufficient testimonies, how favourably the proposal for the extensive employment of aeriform remedies has been received in different parts of the civilized world. At present I shall only remark, that a celebrated American Physician is composing a work, to explain the most remarkable appearances of the yellow fever of PHILADELPHIA, *according to the principles stated in the following pages. Should his explanation be true to nature, the same principles will doubtless suggest effectual means for checking the ravages of this consuming disorder in future.*

No contingencies therefore, it should seem, can altogether put a premature end to these interesting researches. When the time for balancing success and failure shall arrive, the result, I trust, will not diminish the satisfaction you must have derived from cases within your certain knowledge.

I am, dear Sir,

Your's with sincere esteem,

THOMAS BEDDOES.

Clifton, Feb. 10, 1796.

ADVERTISEMENT.

THE additions to this third edition, which appears so soon after the second, though not very numerous, are of some importance. That the purchasers of the second edition may have no cause of complaint, their substance shall be given in part IV. which however, will not very speedily appear. These additions consist chiefly of letters from Dr. JENNER, Dr. R. PEARSON, Mr. ATWOOD, BENT, FIELD, and SANDFORD. The Author is glad to have it in his power to announce Mr. WATT's intention of publishing some new Observations on the application of chemistry and mechanics to the relief of the sick.

Since the distribution of the second impression of the Author's *Proposal for a Pneumatic Institution*, queries have been put to him which he scarce knows how to answer, because he finds it difficult to express his thoughts more distinctly than he has already done.

Had the respiration of elastic fluids, in so many trials, never produced the desired effect, there could have been no inducement to attempt improvements in the method of administering them: had they not frequently operated as mere palliatives in the simple way in which they have been administered, and frequently failed altogether, there would be no need of an Institution for the purpose of investigation,

In attempting the ſmalleſt good, circumſtances will inevitably occur to provoke diſguſt. When any ſcheme, that requires contributions is talked of, perſons pre-determined not to part with their gold, will often give futile reaſons, inſtead of a frank refuſal. By refuting theſe reaſons ten times over, you will only teaze yourſelf. The little ſecret motive, "the boſom's lord," ſits all the while unaſſailable by rhetoric or reaſoning. In ſuch hopeleſs caſes, I preſume to offer a ſhort piece of advice to the promoters of the deſign. *Maturus desine*—quit parley forthwith, and ſpare your unavailing pains.

T. B.

Clifton, Feb. 10, 1796.

PREFACE

TO THE SECOND EDITION.

THE former edition of this pamphlet, consisting of between 500 and 600 copies, appeared in the middle of October, 1794. The booksellers had disposed of most of the copies in a few weeks; and in less than four months a new impression became necessary. As the British market for professional publications is most discouragingly narrow, may not this brisk demand be regarded as the token of a rising disposition in mankind to take what belongs to their welfare into their own consideration; and to emancipate themselves still further from the danger and servility of implicit confidence?--- Presuming that the present edition will likewise fall into the hands of persons, indifferent about medical literature in general, but anxious to form an opinion concerning the virtues of elastic fluids; I shall endeavour to obviate the effect of certain cavils, which will perhaps be urged with greater vehemence, as the projected improvement seems more likely to answer. In the past and present state of medicine there are several circumstances which may, in my opinion, be successfully employed for this purpose.

1. Let

I. Let the means by which alone it is poſſible for human ingenuity to improve this or any other art be firſt conſidered; and afterwards the difficulties it has been neceſſary to ſurmount before the moſt powerful articles of the *Materia Medica* could be brought into train. To diſcover an efficacious method of adminiſtering quickſilver, without inflicting the moſt ſevere torture upon the patient, required the ſucceſſive efforts of many generations. Opium has been longer known and much more frequently exhibited; yet the number of thoſe, who underſtand its properties ſo as to employ it ſafely and with its full effect, is at this day incredibly ſmall. Nor would a ſtranger to the records of medicine ever conceive by what ſufferings, and, to palliate nothing, by what ſacrifices our preſent knowledge of theſe two ſubſtances has been obtained. This is a melancholy retroſpect; but before you give way to ſympathy, pauſe to conſider what the alternative would have been. We poſſeſs the moſt authentic documents; and from them we may collect that the number of miſerable lives and miſerable deaths would have been many million times greater, if our predeceſſors had not perſevered in their endeavours to maſter theſe active bodies. Such is univerſally the condition of human affairs; and the miſeries of the preſent age will work out the redemption of poſterity.

If

If you purſue this train of thought, you will, after ſome heſitation perhaps, be led to a concluſion oppoſite to that of the acute author of the work, entitled *Medicine pernicious to Society* (a); but if you limit the queſtion to the paſt and the preſent, and comprehend practitioners of all titles and of both ſexes, I dare not deny that for one pang that has been eaſed, an hundred have been inflicted: for one life that has been preſerved, twenty have been deſtroyed.

It would not therefore have been a ſufficient reaſon for abandoning elaſtic fluids in diſpair, if in caſes where there was no chance of other help, ſome ſuſpicious circumſtances had ariſen after their uſe.—They have however now been very frequently and largely adminiſtered; and ſometimes in a ſtate of debility but juſt compatible with life. My attention and enquiries have been particularly directed to bad conſequences. Yet I know only of three inſtances, where any inconvenience, more worthy conſideration than the ordinary effect of an emetic, has been experienced. In the worſt of theſe I had the mortification to be concerned; it is the caſe of epileptic affection related in my *Collection of Letters*. The patient is now as before the inſpiration of the modified air; nor has

(a) La Medecine nuiſible à la Societé by Dr. Gilibert, a Medical Profeſſor of Montpellier.

has any thing worth mentioning occurred in the mean time.——Of the other cafes Dr. Carmichael gives an accurate report p. 69-72: There is not, I believe, the leaft reafon to fufpect that life has been even once fhortened in thefe attempts to relieve hopelefs diftrefs. Had fuch an event fallen under my notice, I fhould have defcribed it as circumftantially as the moft brilliant cure. Of the obfervations I fhould myfelf make, it was my original determination to relate fuch as might infpire caution rather than fuch as might fuggeft to high expectations; and I fuppofe common fenfe will dictate to every perfon in the fame circumftances the policy of watching and reporting effects in the character of an adverfary rather than of an advocate.

To imagine poffibilities is one thing; to judge of realities is another. The imagination, I prefume, may very allowably range the unexplored receffes of Nature in queft of remedies for frequent and fatal diforders. If any thing that appears capable of fupplying fo great a defideratum fhould occur, you muft of neceffity, in applying to its ufe, be guided by views or expectations, previous to direct experience. To frame analogical hypothefes concerning the operation of untried agents (unlefs the hypothefes be abfurd, that is, contrary to well-eftablifhed

lifhed facts) can, therefore, bring no man's judgment into queftion, except with thofe who feel it their intereft to confound, or who want capacity to diftinguifh, things effentially different. In the daily declamations againft proceeding upon analogy in the practice of phyfic, there is fo little meaning that the declaimers are continually endeavouring to avail themfelves of this refource; they are only unconfcious of what paffes in their own minds. But to adhere to fpeculation in oppofition to the evidence of experiment, is, I acknowledge, a degree of weaknefs, equal to the criminality of prevarication or direct falfehood, for the fake of gaining a lucrative reputation. My coadjutors appear to have been actuated by the fame fentiments: and the impartial and intelligent may, I think, be fafely challenged to determine how far their reafonings are diftinguifhed by philofophical fcepticifm, and their reports by the aufterity of truth.

In our clinical obfervations we muft all be fenfible that there is a degree of immaturity, which time only could remove. But it feems too obvious to require proof that the progrefs of the art and the advantage of patients are beft confulted by fpeedy publication, provided the ftatement of facts be accurate as far as it goes. This is certainly the quickeft way of multiply-

ing

ing observers; and thus I expect the machinations of empirics and monopolists will be defeated.

II. No one will pretend that factitious airs are inert; and since they have been so freely used with so little injury, may we not safely persevere, till their virtues be ascertained? Is it too soon to conclude that the caution, at all times necessary in the practice of medicine, is sufficient for the security of the sick? and that any unfortunate event in future ought to be imputed to rashness, to ignorance, or to one of those mistakes in consequence of which the noblest remedies have sometimes proved pernicious? It is beyond expectation fortunate that the time of natural death should have in no instance coincided with the first administration of elastic fluids. For I saw Craft and Timidity, which formed a league to expel Peruvian bark from the shops, to oppose inoculation, and to decry the cool treatment of the small-pox, ready to take advantage of any event that might bear an alarming interpretation.—— That so little opposition and so little pretext for opposition has arisen, I impute to a variety of causes; to skill and care in individuals; to our superior knowledge of the nature of animation; to instructive experiments upon animals; and, above all, to that power over invisible and impalpable agents which we derive from mechanics and chemistry.

III. By feveral who viewed this project with an evil eye, it was doubtlefs expected that it would be defeated by its own difficulty. But it has efcaped this danger, and others, according to the courfe of medical tranfactions, await it. That which will arife from the following caufe I regard as moft to be dreaded. Unlefs the enemies to improvement facrifice their fees to their ftubbornnefs, they will be compelled by the urgency of patients to employ the new method or to *make believe* they do. In what difpofition of mind they will fet about the trial may be conceived by thofe who recollect the occafion on which the Jew in Shakfpeare demands

"On what compulfion muft I, tell me that?"

Modern inftances might eafily be adduced where an active and well-recommended material has been prefented to the public, as unfit to be prefcribed, on the authority of cafes in which it had been converted by the enormity of the dofe into a poifon. When factitious airs fall into the fame hands, we fhall, I dare fay, be furnifhed with inftances in plenty of their injurious effects; for I repeat what I have already taken fome pains to inculcate, that like all efficacious remedies they are capable, when mifapplied, of producing the moft fatal confequences.

IV. Knowledge is never exact but when it involves abfolute or comparative quantity.

To

To perceive clearly in what eſtimation the general art of healing in its preſent condition deſerves to be held, we ſhould know,

1. The number of caſes where it can effect a cure, though no ſpontaneous recovery would take place.

2. The number of caſes where we are helpleſs ſpectators.

3. The pain we can ſave patients whether ſpontaneous recovery will or will not take place.

Were theſe quantities aſcertained, the figures on the melancholy ſide of the account would, I fear, run tremendouſly high. But let us ſuppoſe that in a given diſtrict there are 10,000 patients, where the drugs in uſe can neither preſerve life, nor in any conſiderable degree mitigate pain. Of theſe 10,000 caſes let it be aſſumed that in 1000 or in half the number factitious airs are capable of re-eſtabliſhing health, and in 2000 others that they will prove better palliatives than we poſſeſſed before. That their efficacy will hold ſo high a proportion I by no means affirm; though facts ſeem to warrant very favourable expectations, and the ſignal virtues they have manifeſted in internal and external ulcerations, that is to ſay, in curing or relieving the moſt fatal and excruciating

ating of human maladies, is a moſt encouraging conſideration. But though their advantages ſhould require to be expreſſed in much lower terms, it is obvious that they may ſtill be an acquiſition to humanity; and I have offered a numerical ſtatement merely to evince their value, if they ſhould prove ſerviceable in any ſpecies of diſeaſe, though they fail in all others. The habit of analyſing medical facts is ſo uncommon that the diffident and the uninformed might by a little management be led to infer general want of power from partial inefficacy. It was accordingly remarked to me by a phyſician, acquainted with the hiſtory of his art, the feelings of his brethren, and the ſpirit of the metropolis, " that ſome patients might poſſibly " be cured by breathing this or that air; as " others are by ſwallowing this or that drug. " But the method, unleſs myſteriouſly practiſed, " cannot ſoon obtain credit; perſons out of " the profeſſion are too indolent or ignorant to " concern themſelves about its pretenſions: it " appears troubleſome and would put the fa- " culty too much out of their way; I think " therefore ſucceſs in twenty inſtances will not, " at preſent, be ſo likely to recommend it, as " one failure to bring it into diſcredit."——I acknowledge the ſhrewdneſs of theſe remarks; and I am ſenſible that it is a thing of itſelf by no means deſirable *to put the faculty out of their way.*

way. But ſuperior conſiderations will eaſily occur; and it remains to be ſeen whether the public judgment, almoſt 200 years after the time of BACON, is ſo enfeebled by medical ſuperſtition, as to yield in a matter of ſuch moment to vague preſumptions and opinions of queſtionable origin.

To the former edition I prefixed a propoſal for a MEDICAL PNEUMATIC INSTITUTION. A *temporary* public eſtabliſhment might, I conceived, be ſo contrived as greatly to aſſiſt in deciding how far elaſtic fluids will be of ſervice in diſeaſes, which are a reproach to the art and mines of gold to its profeſſors.----Among the peculiar advantages of ſuch an inſtitution perſons of information appear to have been moſt ſtruck with the following. 1. To a complete trial of this practice it might be neceſſary to fill apartments with modified air: Even unfavourable concluſions ſhould be eſtabliſhed in ſuch a manner as to leave no regret behind; and perſons of enlarged views will, I ſuppoſe, aſſent to an obſervation of Mr. Thomas Wedgwood, "that it is worth while to expend "the ſpecified ſum in order to aſſure ourſelves "that elaſtic fluids will not be ſerviceable as "medicines." 2. It would be deſirable to have the means of applying this practice to animals ---as dogs and horſes---labouring under dangerous or fatal diſorders. 3. We might carry on phyſiological

physiological investigations of longer duration and greater extent than have ever yet been devised, with a view to discoveries, applicable to the practice of physic. 4. As all imaginable precautions would be taken to authenticate facts and give them publicity, a large quantity of matter for reflection, if not of knowledge immediately useful, would be thrown into circulation. 5. Observations on private patients may suggest modes of applying air, not easily practicable but in an appropriated building. 6. It may be expected that men of genius, having such assurance that all reasonable suggestions would be realised, would universally exert their inventive powers in behalf of humanity.

According to the common acceptation of the term *charity*, the proposed institution must be regarded as essentially different from ordinary charitable foundations. It is calculated for the benefit of the wealthy as well as of the indigent; in other words, to relieve the distress universally arising from the imperfect state of medicine, and not from poverty in particular. It can scarce be suspected as a private or party job; there are few individuals incapable of judging how far the undertaking is unnecessary; for there are few who have not seen some friend tortured long or prematurely cut off by a disorder, which has baffled the skill of those in

whom

whom moſt confidence was placed, and from which they themſelves are furniſhed with no exemption.

The propoſal having been ſome months before the public, it may be expected that I ſhould ſay ſomething of its reception. It has incurred ridicule; that was in order. It has alſo been commended; indeed, if I may credit the reports of ſome correſpondents, and if *words* could procure workmen and materials, the preſent age might have conſecrated to humanity an edifice more ſplendid than the monuments of oriental ſuperſtition. Theſe commendations however might be mere civilities; but I can ſeriouſly affirm that no deſign has ever been ſanctioned by more reſpectable ſupport. The ſum at preſent ſubſcribed does not, I believe, exceed * ſix hundred pounds. But among the ſubſcribers will be found a majority of the perſons, eminent in Great Britain and Ireland as improvers of medical and philoſophical ſcience. Their names ſhall ſpeedily be given to the public. But I think it due to departed worth to record on the preſent occaſion that the promotion of this deſign was among the laſt acts of the ingenious and public-ſpirited Mr. Wedgwood. In my former advertiſement I thought myſelf bound in juſtice to mention the liberality

* It is now more than Eight hundred.

lity of Mr. William Reynolds, of Mr. Joseph Reynolds, and Mr. Yong, surgeon, of Shifnal, Shropshire. In 1792, when I pointed out the principles on which I imagined beneficial consequences might result from the free use of elastic fluids as medicines, these persons agreed with me to risque a sum not exceeding two hundred pounds each, in order to bring my conjectures to a proper trial. An apparatus was accordingly erected; an operator engaged, and in 1793 I made many of the following experiments. At the same time it was ascertained that the practice might very safely be pursued: and a prospect of advantage offered itself. Upon this first essay was expended no inconsiderable part of the sum we had determined not to exceed.

I have observed of late certain expressions in print, from which strangers to the real circumstances might suppose that several other persons had co-operated with me in attemping to improve Medicine, in consequence of previous connexions in private life. But there has been in this proceeding nothing of narrow partiality towards an individual, nothing of collusion or cabal. The real motives of those who have stepped forward are so much more honourable to themselves, and to the cause in which they engaged, that such misapprehension ought to be

be obviated. In truth, I have not even a personal acquaintance with the majority of thoſe by whom I have been favoured with communications; nor had I the leaſt previous intimacy or correſpondence with any one among the number, excepting a phyſician eminent for the variety and energy of his talents; and our acquaintance was confined to an intercourſe of letters on ſubjects of medicine and philoſophy.

Advertiſing the propoſal and contribution in the London papers has been delayed longer than was intended. But the neceſſities of the poor during the late diſaſtrous ſeaſon were ſo urgent that it was thought the public would not pay much attention to other applications for ſubſcriptions. As ſoon as the contributions amount to fifteen hundred pounds, I ſhall propoſe to the ſubſcribers to proceed to the execution of the deſign, in hopes that the ſum further neceſſary, will afterwards be raiſed.-- I have ſometimes been aſked if it would not be better to defer the project till peace be reſtored? I think indeed that leſs difficulty would have been experienced in time of peace; but I have thought it not improper to reply by another queſtion: *If you admit the propriety of the measure at any time, ſhould a nation like this defer a plan, requiring for its execution no more than 3 or 4000l. and calculated to rescue multitudes from suffering and death? Can you suspend*

the

the progress of disease, till you are at leisure from the pressing concerns of the war to contribute your mite towards the alleviation of distress, which is gnawing the bosom of innumerable families? Besides, where is our security, that at the cessation of hostilities, or shortly afterwards, we shall be better able or more willing than at present to execute schemes of beneficence? And would it not be a cause of just regret if we should suffer to pass away so noble an opportunity of deserving well of mankind, at such a trifling cost?

The following Bankers in London have obligingly agreed to receive Subscriptions for the Medical Pneumatic Institution: Messrs. Coutts and Co. Sir J. Esdaile and Co. Messrs. Pybus and Co. Messrs. Ransom and Co. Mess. Smith, Payne, and Co. Mess. Staples and Co. ----Sir Benj. Hammett, Alexander Anderson, Esq. and John Grant, Esq. have consented to hold the money subscribed, as Trustees, till the execution of the design commences.

PART I.

EXPERIMENTS, CAUTIONS, *and* CASES tending to illustrate the medicinal use of FACTITIOUS AIRS, and of other substances, of which the application to Medicine has been suggested by modern philosophical discoveries.

I. — *Of the Atmosphere.*

IT is proved, by satisfactory experiments, that the inferior region of the atmosphere consists of two kinds of air, quite distinct in many properties. One is the kind called VITAL, DEPHLOGISTICATED, or OXYGENE AIR, and by a variety of names besides. The other has been named AZOTIC, PHLOGISTICATED, FOUL, or BAD AIR. Where the lower atmosphere is not altered by the breathing of animals, the burning of fuel, by exhalations from subterraneous chemical processes of putrefying substances, and such local causes, if you confine and examine an hundred cubic inches, you will find twenty-seven or twenty-eight to be oxygene and the remaining seventy-two or seventy-three azotic

air. The manner in which air may be analyſed, is deſcribed in the writings of Dr. Prieſtley, Mr. Scheele, Mr. Cavendiſh, and Mr. Lavoiſier. Theſe authors explain much of the nature of oxygene and azotic air. A candle burns in a veſſel full of oxygene air with dazzling brilliancy, and is conſumed with great rapidity. This air unites with various ſubſtances, and turns them ſour, as beer and milk. Blood taken from a vein is of a dark or livid colour; oxygene makes it bright, florid or ruddy. You may ſee this difference by breaking a clot of blood that has ſtood a little time in the air, ; the ſurface will be crimſon, the inſide dark, and the dark part, now become the ſurface, will turn ruddy, though covered with ſerum. When black blood is put into azotic air, it does not become ruddy. Azotic air extinguiſhes flame, does not burn when mixed or in contact with common air, and is not abſorbed by lime-water.

Near the earth theſe two airs are found mixed with ſurprizing exactneſs. Take a cubic foot from ten different places, and you will find that a little more than a quarter of each is oxygene, and the reſt azotic air. There is often likewiſe found a little carbonic acid air, as one part in an hundred, though no fires burn, or animals breathe near.—The nice balance of attraction between the two conſtituent parts of the atmoſphere, deſerves notice. Theſe two ſubſtances, when cloſely united, form nitrous acid: If, therefore, they were not, by ſome circumſtances, prevented from uniting cloſely, all the oxygene, with part of the azote, would be changed into an highly corroſive acid, and the

waters

waters of our globe would be converted to *aqua fortis*. Again, azotic is lighter than oxygene air; if, therefore, they had not ſome attraction, they might ſeparate, and any animals, that ſhould be immerſed in an atmoſphere of azotic air, would almoſt inſtantly expire: The undiluted oxygene remaining below, would, as we ſhall preſently ſee, occaſion violent diſeaſes in man, as well in many other animals.

II.— *Of the breathing of man and ſimilar animals.*

Fix a pipe to a bladder full of air, and, holding your noſtrils, breathe the air for ſome time, and your diſtreſſed feelings will inform you that it is no longer fit for breathing. If you transfer this breathed air into an inverted glaſs jar full of water, and turn up the jar ſo as to keep in the air, and admit none from the atmoſphere, you will find that it extinguiſhes a candle, and deſtroys the life of a ſmall animal, dipped into it. If you procure another quantity of ſuch air, and add to it a little more than one fourth of oxygene air, a candle will burn in it juſt as in the atmoſphere; and you may breathe it as long as ſo much freſh air, though it is not exactly the ſame; for it contains, after being breathed, ſome fixed or carbonic acid air, either thrown out from the blood, or formed in the lungs. Theſe experiments indicate, that breathing renders common air unfit for ſupporting life or flame, by depriving it of oxygene. Various other experiments ſhew further that this is the caſe. The blood, before it paſſes through the lungs, is dark; after paſſing, it is florid; dark blood in a bladder, expoſed to the atmoſphere, becomes florid ſuperficially; and in breathing, the blood

 and

and air are only ſeparated by membranes not unlike a bladder. When dark blood is introduced into veſſels containing oxygene or common air, the blood becomes ruddy, and the air is reduced in quantity. Hence it appears, that the blood conſtantly drinks up a portion of the oxygene air, received into the lungs; and from various conſiderations I conclude that it is conſumed in the contraction of the muſcles, and in the formation of ſeveral fluids, ſecreted from the blood: for the blood, after traverſing the body, comes back to the lungs dark, or without the oxygene, which it received in paſſing through them. In ſaying that this principle is *conſumed*, I mean no more than that it enters into new combinations; quitting the blood and muſcular fibres, and forming perhaps an ingredient in thoſe ſalts which the bones and fluids are found to contain.—It has been calculated, that, an healthy man requires about five cubic feet of air, or $1\frac{1}{2}$ cubic feet nearly of oxygene air, every hour.

So much is premiſed to render the following experiments and ſpeculations intelligible to ſome readers. —They will find more in Dr. Goodwin's *connection of life with reſpiration*, Mr. Coleman's *diſſertation on ſuſpended reſpiration*, Dr. Menzies' *Tentamen de reſpiratione (Annales de Chimie*, 1791, p. 211) in my three publications on the propriety of employing elaſtic fluids in various diſorders, and the chemical authors already quoted.

It appears that the ſkin imbibes and exhales air. It will imbibe various kinds; but, as it is found in equal times to take in three or four times as much oxygene

air.

air as any other, it probably selects oxygene alone from the atmosphere. Some philosophers suppose the human species to have existed in a monkey state; would the air then so much prevent the cutaneous absorption of oxygene as the cloaths at present? — From these experiments it may also be conjectured that immersion of the naked body or limbs in different airs might cure diseases.

III.—*Though the proportion of oxygene in the atmosphere may be best adapted to the average state of health, may the proportion not be smaller than is beneficial in some disorders, and larger than in others?*

Considerate persons will, I conceive, reply, that this is probable. I have made many experiments on animals, to illustrate the effect of atmospheres of various constitutions. I should have made more, had I not been absent from England, or otherwise occupied for a good part of the last 12 months. No investigation of greater importance or extent, can be imagined. This is only a rude beginning. Others will assist in continuing the enquiry.

IV.— *The effect of breathing oxygene air little diluted.*

Dr. Priestley and Mr. Lavosier found animals either to die, or to become exceedingly ill in such air, while it continues more oxygenated than the atmosphere, and will support the life of other animals. It is not then defect, but excess of oxygene, that is pernicious here. The heart and arteries pulsate more quickly and forcibly; the eyes grow red and seem to protrude;

trude; the heat of the body is ſaid conſiderably to increaſe (a), ſweat to break out over the whole body, and fatal mortification of the lungs to come on. Theſe appearances denote violent inflammation: animals have always appeared to me to ſuffer extremely, ſoon after immerſion in unmixed oxygene air. The human ſpecies, I think, will be found to vary as widely in the manner in which this elaſtic fluid affects various individuals as in any quality whatſoever. Some, I have obſerved, not to be very ſenſibly affected by it when reſpired pure. To my own lungs, it feels like ardent ſpirits applied to the palate; and I have often thought I could not ſurvive the inſpiration of oxygene air, as it is driven from mangancſe by heat, many minutes. The production of inflammation is fully eſtabliſhed by diſſection, as others have found, and as appeared from the following experiment: — A large kitten was kept ſeventeen hours in a veſſel containing ſeveral cubic feet of air from manganeſe, of which about eighty parts in a hundred might be oxygene. This, and another kitten of nearly the ſame ſize, which had lived as uſual, were then diſſected, in my preſence, by Mr. Guillemard, of St. John's College, Oxford, who imdiately made the following minute of the appearances: — "The lungs were of a florid red color in the
" oxygenated kitten (A); in the other (B), they were
" pale; the difference was very ſtriking, both in the
" inflated and uninflated ſtate; the edge of one lobe
" in A was marked with livid ſpots (as in mortifica-
" tion). The pleura was likewiſe evidently inflamed.
" The heart in A was of a florid red colour. The
" liver,

(a) Girtanner Antiphlogiſtiſche Chemie, p. 263.

"liver, kidneys, ſpleen, and blood-veſſels of the me-
"ſentery and urinary bladder, were of a brightiſh red
"colour. In B, the heart was of a deepiſh colour.
"The liver, ſpleen, kidneys, and blood-veſſels, in ge-
"neral, were of a bluiſh or purple colour. Both kit-
"tens had been ſucceſſively killed by immerſion under
"water. Upon opening the head of A, there was no
"appearance of inflammation.—The blood veſſels had
"rather a florid colour; but there was no ſign of ex-
"travaſation, or more than the uſual quantity of blood.
"In B, on raiſing the ſkull, there appeared a quantity
"of blood between the bones and the membranes of
"the brain, of which the blood-veſſels were turgid
"with dark-coloured blood.

"In A, the heart readily obeyed the ſtimulus of prick-
"ing: The ſpontaneous contractions of the right au-
"ricle and ventricle were frequent; they continued
"with little diminution of frequency and force for
"above half an hour. In about an hour, they had
"wholly ceaſed.

"In B, the irritability of the heart was at firſt equi-
"vocal. On opening the pericardium half an hour
"after the ſternum had been removed, the motions of
"the heart became very viſible; they continued more
"than an hour after the firſt expoſure of the contents
"of the thorax."

The univerſally diffuſed florid colour in A was particularly ſtriking; ſo was the dulneſs of one heart at firſt, and the vivacity of the other. Of the latter, I believe the ſpontaneous pulſations were in all many

times

times more frequent and forcible; though this circumſtance deſerves more particular examination than we beſtowed upon it. The kitten A had eaten ſome time after being put into the reſervoir, as appeared from food introduced at the ſame time. The air ſeemed to have ſuffered little diminution either in quantity or quality: the reaſon will appear from a ſubſequent experiment. On cutting the wind-pipe of A, to blow up the lungs, a good deal of viſcid mucus flowed out. This was occaſioned by ſtrong action continued for ſome time, and was not ſeen in any thing like the ſame degree in B.

V. — *Experiments to aſcertain the condition of the venous blood in animals made to reſpire oxygene air.*

Upon comparing the experiments made upon blood out of the body, I was formerly uncertain what might be expected to be the effect of hyper-oxygenation of the ſyſtem upon the colour and other qualities of the venous blood. (See my obſervations on conſumption.) Many ſubſtances, containing oxygene, brighten venous blood, but oxygenated marine acid, according to ſeveral foreign chemiſts of reputation, has an oppoſite effect. Mr. Guillemarde and myſelf often noticed the dark appearance of the veins in animals charged with oxygene, and of the blood they diſcharged when wounded. To inveſtigate this point more particularly, one of two equal half-grown rabbits was kept fifteen minutes in a mixture of three parts of oxygene air from heated manganeſe, and one part of atmoſpheric air. Both were killed by blows on the back of the head, and opened nearly at the ſame time. This experiment

periment was made in the presence of Mr. William Clayfield, and Mr. Bowles, Surgeon, of Bristol. In the oxygenated rabbit neither the *vena cava* itself, nor blood taken from it, appeared less dark-coloured; we thought (but were not certain) that it was rather more so. The blood of the oxygenated rabbit coagulated much more rapidly. The liver also was of a much less dark colour in this rabit.

The blood of both gained its usual florid colour on standing exposed to the air.

Experiment 2. — Of two equal and nearly full-grown rabbits, one was kept a quarter of an hour in undiluted oxygene air, prepared as before. Both were then killed and opened, as before, by Mr. Bowles. In the oxygenated the following were the appearances. The veins were certainly not of a lighter colour, nor the blood. A quantity from the *vena cava* of both rabbits was received in tea-cups. When it was spread thin on the sides of the vessel, we thought the oxygenated blood had a purple or claret colour, which was not perceptible in the other: Mr. Bowles likewise thought its general appearance rather darker. Its coagulation, as in the former experiment, was more speedy; and the coagulum, as I thought on examination afterwards, was firmer. — The liver was less dark.

On the margin of the lungs in the oxygenated rabbit, we observed florid spots in shape and situation like those I had formerly seen on the lungs of animals long confined in oxygene air; and which I take to be points of inflammation.

We observed signs of much stronger irritability in the right auricle and ventricle, in the diaphragm and the

the intercostal muscles of the oxygenated rabbit. They ontinued longer too in this. But considering the force and frequency of the contractions, the quantity of action would have been greater in the oxygenated, had the irritability continued five times as long in the other.

These phænomena made me wish for an opportunity of oxygenating animals of large size, as horses, and of drawing blood from their veins and arteries both before and afterwards. Such a train of experiments would form a very interesting supplement to Mr. Hunter's researches concerning the *general principles of the blood.* (*See his Treatise on the blood, inflammation, and gun-shot wounds, p.* 11—100.) The speedier coagulation of the oxygenated venous blood I think remarkable, and, as it happened in three experiments, it probably was not accidental. The more vigorous action of the oxygenated muscles too deserves to be compared by a course of experiments with the tendency of oxygenated blood to coagulate sooner. Several persons, of whom all did not know the one rabbit from the other, found the boiled flesh of the oxygenated, in both cases, more stringy, harder, and less juicy. The difference was most sensible in the young pair. The greater stringiness was apparent on both these occasions to the eye.

We observed that the rabbits drank repeatedly during their confinement in oxygene air. The latter had been watered a short time before; I could not learn whether the former had or not. Perhaps this thirst (if such it was) depends on the excitement produced.

The

The conclusion directly deducible from these experiments, is, that the blood parts with that excess of oxygene upon which its florid colour depends, before it gets into the large veins, or indeed into any of the visible veins. The altered colour of the solids shews where the oxygene remains. But as we can never get to the end of our physiological enquiries, a further problem may be proposed :—" If the oxygenation be " continued very long, will not the solids be so " highly charged as to be able to take no more oxy- " gene from the arterial blood? and will it not pass " florid into the veins?"—If this does not happen, there must be some contrivance in the system to throw this principle prepetually from the solids. These who do not think that oxygene combines with the blood during respiration, have only to change the terms of my conclusion. The fact remains.

VI.—*Experiments with air, containing somewhat more oxygene than the atmosphere.*

In my letter to Dr. Darwin, I conjectured " that if " before immersion divers were to breathe air of an " higher than the ordinary standard, they would be able " to continue longer under water," (p. 13). I made several experiments to determine whether this supposition was just; in each two animals of the same litter were employed; and as several spectators were sometimes present, they were desired to fix upon the weakest for oxygenation. The following report I literally transcribe from my journal, as it was settled and subscribed by the spectators: " August 20th, 1793. " Kitten C was placed in a mixture of nearly two- " thirds oxygene air from manganese, and one-third " atmospheric

" atmofpheric air; it was kept twenty minutes in the " veffel, which was from time to time fupplied with " oxygene air, fo as to keep the air better than atmo- " fpheric air; which was known by dipping a candle " into it, and obferving that it burned with a brighter " flame. At the expiration of the twenty minutes, C " and D, which latter had breathed atmofpheric air, " were immerfed in water till perfect afphyxia came " on. At the inftant they were taken out, there ap- " peared in both a motion of the lower jaw; C began " fenfibly to recover, while D lay as dead. In a mi- " nute and a half, C rofe, and began to walk about the " room, ftaggering at firft, D being ftill motionlefs, or " nearly fo: in this ftate it continued for fifteen mi- " nutes, when, for the firft time, it raifed itfelf, and " immediately afterwards fell on its fide.

" CHRISTOPHER MACHELL.
" RICHARD LOVELL EDGEWORTH.
" J. GUILLEMARD.
" JAMES SADLER.
" THOMAS BEDDOES.

" Kitten D died the next day."

Of many fimilar experiments, it is fufficient to obferve, that the refult was always in fome degree the fame; fometimes the unoxygenated animal failed to recover; it was generally noticed that the oxygenated fhewed figns of life under water the longeft; and fometimes that it ftruggled as much as ever after its unoxygenated fellow had ceafed to move. Thus, in an experiment (September 28) a whelp, which had refpired atmofpheric mixed with one-third of oxygene air for thirty-four minutes, is regiftered to have been as much alive as before immerfion under water, another puppy

of

of the same litter unprepared, and immersed at the same time, having become motionless. These facts illustrate the query concerning divers. To obviate any mistake from difference of constitution, the experiment was sometimes repeated upon the same pair of animals, one being oxygenated one day, and the other the next, or the day following. The water in which they were drowned, was sometimes heated to the temperature of the body.

But as unequal quantities of liquid have been found to get down the wind-pipe of drowning animals, it seemed proper to repeat the experiment in another manner.—Accordingly, of two greyhound puppies of the same litter, ten days old, E the weaker was kept an hour and fifty minutes in a mixture of two-thirds of atmospheric air, and one-third of oxygene air from heated manganese. F was left as usual: Both were then immersed in hydrogene air. F soon appeared much agitated, and expressed much uneasiness. E moved very little, and soon placed itself in the couchant posture, with the head between the fore-legs and the muzzle resting on the bottom of the vessel. In five minutes, F was lying on its side, now and then breathing, which it did less and less frequently and more feebly. In ten minutes, this effort was scarce preceptible: In two minutes more, it was not once repeated. For the last six out of the twelve minutes, E was so perfectly still, that we were disposed to believe it dead; and a person present said, "this experiment will turn out ill for oxygene." During these last six minutes, E had not inspired at all; and from the first, the respiration was very infrequent.

At

At the end of the twelve minutes, both puppies were taken out of the hydrogene air; E immediately cried and ſtruggled, F being quite motionleſs. They were laid before a fire; E cried, moved, and ſoon walked as uſual; F ſeeming quite dead. In ſixteen minutes, a ſtream of oxygene air was blown into F's mouth, but no ſign of life appeared. The animal was afterwards opened; upon irritating the pericardium with a pointed knife, ſo as to preſs upon the heart, no movement followed; the pericardium being removed, the heart began to contract ſpontaneouſly: a ſtream of oxygene air being directed upon the heart, its action become more ſtrong and frequent; the number of ſtrokes was about ſeventy in a minute. The colour of the heart (probably from the filling of its own blood veſſels) changed from pale to red. The difference of colour in the tongues of theſe puppies was ſtriking, after the experiment, even by candle light, that of E being much more ruddy. The following variation ſeems worth tranſcribing from the journal: Of two puppies of the ſame litter, the weaker G was kept in atmoſpheric air mixed with one-third oxygene, and H for an equal time in atmoſpheric air with one-third hydrogene. Both were plunged into tepid water. H became motionleſs, while G moved with force, cried on being taken out, and ſeemed little affected.

The effect of oxygene air was very ſtriking in recovering H. It began to move, and inſpire the moment it was put into a veſſel containing this air.

It was ſometimes obſerved, that the movements of very young puppies under water, did not entirely ceaſe in leſs than fifteen minutes.

VII.—*Neceſſity*

VII.— *Neceſſity of oxygene air to muſcular exertions.*

The blood in the veins is dark; in the arteries it is bright. When the reſpiration is ſtraitened, the arterial blood becomes darker; when acceſs of oxygene air is prevented, all the blood becomes dark. In drowned and ſtrangled perſons, the face, lips, the ſkin under the nails, and ſome other parts, are of a violet or dark blue colour. Here the blood can receive no oxygene. There are a number of caſes on record where, from bad conformation of the heart and adjacent great blood veſſels, part of the blood only traverſed the lungs; the reſt paſſed into the arteries again in the dark diſoxygenated ſtate in which it returns from the veins. Such perſons are always blue or livid. They are extremely feeble; in walking, are ſometimes obliged to ſtop every third ſtep, nor can they make any exertion of the muſcles without inſtant panting and wearineſs. They commonly die ſuddenly; you will find an account of ſuch individuals in *the Commentaries of the Inſtitutions at Bologna*. Vol. 6, p. 64. *Philoſoph. Tranſactions*, vol. 55, p. 72. *Medical Obſervations and Enquiries*, vol. 6, in my *Medical Obſerv.* p. 62. *Abernethy's Surgical Eſſays*, part 2— Perſons ill of ſea-ſcurvy, often drop down dead in making a ſudden effort, and from ſurprize. There is reaſon to believe, that either living in confined air, or on ſalted food, occaſions a deficiency of oxygene in the fluids and ſolids.

Hence, if a perſon were to keep quite ſtill, a given quantity of air ſhould ſerve him to breathe longer than if he exerted himſelf. Thus ſhould any perſons find themſelves again in the ſituation of Mr. Holwell and

his

his fellow-sufferers in the Black-hole prison at Calcutta, their best chance of surviving would probably be to forbear vehement struggles. The fever of the survivors appears to have been occasioned by the great stimulating power of fresh air, and of the sensations their escape must have occasioned.

The following experiments render probable the expenditure of oxygene in muscular exertion. They do not, however, absolutely prove this position; nor did their immediate result appear to me so certain as of my other experiments. Of two half-grown kittens of the same litter, one was teazed to make efforts for half an hour, and then put into an air-tight vessel, in which it lived 48 minutes; the other lived 56 m. in the same vessel; it would require more such cruel experiments to decide whether speedier death here arose from previous consumption of oxygene by strong muscular action, and the subsequent necessity of a supply. It should be observed, that the first animal was not respiring more deeply than the second, at the time they were inclosed.

The following fact is remarkable, and countenances, but does not rigorously prove, the hypothesis. A grown cat was inclosed in an air-tight glass vessel.—She immediately became furious to a degree beyond what I ever observed in any animal under experiment. The violent agitation continued for 20 minutes. In 5 minutes more—25 minutes in all—she appeared dead: she was left in the vessel two minutes longer, and proved to be quite dead. A lighted candle was immediately extinguished on being introduced into the vessel.

Into

Into the ſame veſſel another cat of the ſame ſize and age nearly, to which a ſmall glaſs of white wine had been given half an hour before, was introduced. This cat ſat almoſt perfectly ſtill during the whole experiment. It lived 47 minutes, or nearly twice as long as the other.

In order to vary the experiment, half a glaſs of ſherry was given to a kitten nearly grown. It was *immediately* put into the ſame receiver; and ſet to *ſtruggle very violently*. It ſoon appeared to reſpire with difficulty. In 15 minutes the reſpirations were 98 or 100 in a minute. It did not reſpire after the 34th minute, and in 2 minutes more was taken out inſenſible.

A fellow kitten, no way prepared, was placed in the ſame receiver, and remained *very tranquil* for above a quarter of an hour; its reſpiration was never ſo frequent as that of the former; and it raiſed its head and breathed at the end of 41 minutes.

We have then

	Minutes.	Minutes.
An haraſſed kitted living -	48	Difference 8.
Its fellow, not previouſly haraſſed,	56	
A grown cat not prepared, but furiouſly agitated, - - - - - -	25	Difference 22.
Another perfectly tranquil, having drank wine, - - - - - - -	47	
A large kitten immediately after wine, and violent, - - - -	34	Difference 7.
Its fellow tranquil without wine, -	41	

In theſe ſix experiments the ſame veſſel, that is, the ſame quantity of air, was uſed. It may be ſaid, by a

perſon

perſon unuſed to accuracy of terms, " no wonder the moſt exhauſted animals ſhould periſh ſooneſt." By conſidering a moment, he will perceive, that it is deſirable to know preciſely in what this exhauſtation conſiſts. I formerly conjectured that oxygene is conſumed faſter by an animal under the firſt operation of wine or other ſuch ſtimulants; and Dr. Withering afterwards adduced the experience of Mr. Spalding in confirmation of this conjecture. It is not ſo eaſy to make the experiment upon animals; the efforts of ſome under confinement being ſo much more violent than of others. The laſt experiment was made with a view to this queſtion, but the two preceding incline me to refer ſpeedier death in this inſtance to the violent ſtruggles, rather than to the wine.

VIII. — *Another comparative experiment with an animal charged with oxygene.*

Of two half-grown rabbits (K and L) of the ſame brood, colour, ſize, and apparent ſtrength, K was put into a large reſervoir containing atmoſpheric air with a little oxygene. After ſome hours it was taken out, and placed for an hour longer in a mixture of nearly equal parts of oxygene and atmoſpheric air. It did not ſeem to ſuffer in its reſpiration. K and L, which latter had remained at large in the ſame apartment, were then incloſed in a veſſel, and placed in a freezing mixture. In 20 minutes ſome of the cold brine was poured upon the bottom of the veſſel in which the rabbits were: in 30 minutes L ſeemed affected, in 45 was ſcarce alive, and in 55 was quite lifeleſs and frozen ſtiff. K ſeemed ſufficiently lively; only its feet were frozen ſtiff. They were dipped in cold water, and the animal recovered perfectly. I obſerved many convulſions and much tremor of the limbs during recovery,

very. It was between 8 and 9 o'clock in the evening when the rabbits were taken out of the veſſel. K, by 12, had recovered the uſe of its fore legs, and being left not far from a dying fire within the fender, was found in the morning running about the room, when it eat cabbage leaves freely. It was kept alive for a week, when the legs appeared diſeaſed from too quick application of heat at firſt.

The experiment being repeated without admitting liquor into the receiver, the reſult was ſimilar. Would opium and wine enable an animal to reſiſt the freezing mixture, as oxygene does?

IX.—*Experiments with oxygene and other airs, largely diſtributed through the cellular ſubſtance.*

Dr. Maxwell, aſſiſted by Dr. Goodwyn and ſome other friends of accuracy and genius, forced different airs under the ſkin of animals, whence every perſon in any degree acquainted with anatomy, knows they would inſinuate themſelves far and wide through the body, in conſequence of the free communication between different portions of the cellular ſubſtance.—I. 4½ pints of *atmoſpherical air* were forced under the ſkin of a bitch, weighing 20lb. the inciſion was cloſed by a ſuture: the animal appeared uneaſy and indiſpoſed for 36 hours; the puffing did not begin to ſubſide before the 9th day; on the 20th, no air was left except a little about the lower part of the belly.—II. 3 pints of air, in which a light had burned out, were forced under the ſkin of a dog weighing 13lbs. For ſome hours the animal appeared ſtupid. The emphyſema or puffing ſeemed to decreaſe during the 3d day;

day; on the 16th convulſions came on and frequently returned; on the 20th the dog died much debilitated. In three other experiments nearly the ſame phænomena were obſerved.—III. 4 pints of oxygene air were infuſed in the ſame manner into another dog; ſlight uneaſineſs was obſerved for the firſt hour, and afterwards the animal appeared exceedingly lively *(maxima alacritras)*. Next day the emphyſema began to leſſen; by the 10th all the air was abſorbed. In another dog of 19lb. 3½ pints of this air diſappeared in 8 days; in a third of 21lb. 3 pints in 8 days; in a 4th of 20lb. 3 pints nearly in 7 days. The 2d and 3d were affected as the firſt dog; the 4th was in no way affected. —IV. Carbonic acid air was infuſed into ſeveral dogs and rabbits. A large quantity (as much as 2 pints in a dog of 17lb.) diſappeared during the operation; the reſt was gradually abſorbed in 4—14 days. No inconvenience followed, except in one caſe where a pint of air infuſed into a rabbit 3 months old, occaſioned uneaſineſs from diſtenſion; but even here the animal eat with a good appetite in half an hour. The inſtantaneous diſappearance of ſo much air in theſe experiments, was probably owing to its combination with the moiſture in the cellular ſubſtance. Inflammable air (from metalic ſolutions, I ſuppoſe) occaſioned heavineſs and ſhiverings in two dogs; 3 pints in one, 2½ in the other. Some detumeſcence was obſerved on the 4th day in both; in 13 days the air was all gone in the 1ſt, and in the 2d in 9 days.—VI. 2½ pints of nitrous air were infuſed into a dog of 28lb. It howled as if in exquiſite pain: in 15 minutes it ſtaggered as if drunk; then convulſions came on, and vomiting with involuntary excretions. In 30 minutes it lay enfeebled on the ground, making deep and labo-

rious

rious inſpirations, in $54\frac{1}{2}$ it died, the convulſions continuing to the laſt. The heart had all its cavities full, and was quite inirritable. The lungs were of a pale ſaffron colour, and ſhewed no veſtige of red blood. Brain in a natural ſtate. In another experiment $1\frac{1}{2}$ pint of nitrous air produced the ſame effects, and death in 45 minutes. In neither caſe were the external muſcles inirritable. Rabbits died juſt as theſe dogs, and the ſmell of nitrous acid was perceived when the lungs were inflated and left to collapſe. In this theſis (Edinburgh 1787) Dr. Maxwell relates other experiments, in which airs were thrown into the blood veſſels. By one (p 22) he ſhews that elaſtic fluids do not prove fatal till they get into the cavities of the heart. But as theſe latter experiments ſuggeſt no concluſion concerning the medicinal power of elaſtic fluids, I need not conſider them at preſent. Mr. Achard, of Berlin, was the firſt who publiſhed experiments with different airs injected into the cellular membrane. But Mr. Achard is a writer whom you can ſeldom quote with confidence.

X. — *Experiments with hydrogene and other mephitic airs.*

Dr. Prieſtley, (*Exp. on Air, N. Ed.* I. 229) ſays "Inflammable air kills animals as ſuddenly as fixed "air, and as far as can be perceived, in the ſame "manner, throwing them into convulſions, and there- "by occaſioning preſent death." Dr. Prieſtly does not ſay how he aſcertained the former part of this aſſertion, and I apprehend, it will be found erroneous, if it regard pure hydrogene. Mr. Scheele could make 20 inſpirations without inconvenience: and I have ſeen ſeveral perſons breathe ſtill oftener from a tube

 through

through which a current of this air fet, their noftrils not being clofed (*Letter to Dr. Darwin, p.* 44.) Hence I concluded that this bland air might with impunity be breathed unmixed, longer than any other mephitic air, except perhaps azotic. Dr. Macdonald of Belfaft, whofe abilities and fkill in phyfiological refearches muft be well remembered by all who ftudied medicine at Edinburgh ten years ago, confirms me in this opinion "I have tried (he informs me in a letter dated Auguft 13, 1794) "hydrogen air in five pulmonary cafes, in "two of which it had a very fudden and a very fa-"vourable influence. In one of the others the "meafles fupervened upon phthifis, and feemed to "decreafe the firft difeafe. My patients fometimes "refpired hydrogen air for a minute and half at a "time; the more frequently they repeated the expe-"riment, the more eafy did it become: but after 15 or "20 infpirations I always obferved the face to grow "dark and livid. I am aftonifhed at the length of "time which man can breathe, and animals live in, "hydrogen air."

Dr. Gilby of Birmingham noted the following appearances, and immediately afterwards drew out this minute.

"*Hydrogene Air.*"

"A moufe immerfed in hydrogene air—from wa-"ter and heated malleable iron—continued 30 feconds "without fhewing any mark of diftrefs; refpiration "then became laborious: one minute 33 feconds "from the time of immerfion it infpired; but it "moved no more, and when taken out, proved to be "quite dead.

"Fixed,

" *Fixed, or Carbonic acid Air.*"

" Another mouſe, immerſed in this air, was inſtantly " affected; and in 15 ſeconds was completely dead." A young wood pigeon, in hydrogene air, ceaſed to gape and move in 2 minutes 35 ſeconds. For 10 or 15 ſeconds it did not appear incommoded. Its fellow, in carbonic acid air, ceaſed to gape and move in 43 ſeconds. It ſhewed diſtreſs inſtantly on immerſion.

Very young animals do not drown ſo ſoon as old.— Imagining, therefore, that young animals would afford a more ſenſible ſcale on which to meaſure the power of different mephitic airs to extinguiſh life, I made the following experiment. A puppy, four days old, was put into a veſſel of hydrogene air from heated iron and water. It ceaſed to breathe and move twenty-two minutes afterwards. Another puppy, of the ſame litter, was put into carbonic acid gas: it ceaſed to breathe and move in one minute and a half.— Comparative experiments of this kind require repetition; two apparently ſimilar animals may be tenacious of life in different degrees, from cauſes not yet diſcovered: moreover, if immediately before immerſion, one ſhould have inſpired, and the other expired, this might occaſion a wrong inference: nor ſhould dependence be placed on a ſlight difference. By keeping animals, ſeemingly equal, in different unreſpirable airs, till all appearances of life in one or the other had ceaſed; then taking the ſurvivor out, ſuffering it to recover, and after ſome days drowning it again in that air in which its fellow had periſhed before, I hoped to determine this queſtion certainly for the ſubjects of experiment, and by analogy for all animals of the ſame claſs.

Accord-

Accordingly, three rabbits of the ſame litter, ſeven weeks old, nearly half grown, and weighing one pound and a half each, were ſucceſſively immerſed in three different kinds of air. Dr. Gilby being preſent at this experiment alſo, noted the appearances at the moment they occurred.

Experiment I. — Rabbit X.

" *In hydrogene from water and heated malleable iron.*

	Minutes,	Seconds, after immerſion.	
" In	1	20	Moved about, in appearance little diſtreſſed.
	1	50	Began to breathe ſhort.
	2	0	Viſibly diſtreſſed.
	4	15	Much agitated.
	7	0	Taken out, breathing very ſhort and thick.
"In leſs than	17	0	Completely recovered.
" In	40	0	(that is as ſoon as food was offered) began to eat.

" Experiment II. — Rabbit P.

" *In hydrocarbonate air from hot charcoal and water, twice paſſed through water.*

	Minutes.	Seconds.	
" In	0	25	Breathed ſhort, diſtreſſed.
	0	35	Violently agitated, continued ſo 15 ſeconds ; inſpired at long intervals for ſome ſeconds: ſcarce alive,

" After

	Minutes.	Seconds.	
" After	1	30	No inſpiration or movement ſeen.
" In	4	0	Taken out for dead—did not recover.

Experiment III. — Rabbit Q.

" *In carbonic acid air, from heated chalk.*"

Minutes,	Seconds, after immerſion.	
" 0	20	Strongly convulſed.
0	35	Gaſped at intervals.
0	49	Has continued gaſping.
1	0	Nearly dead.
1	15	Quite dead.
2	0	Taken out, perfectly inanimate, did not recover.

Experiment IV. — Rabbit R.

At the time of making theſe experiments I had not pure azotic air at command, and had neglected to uſe it when I had; the following obſervation makes it highly probable, that this air is not more ſuddenly deleterious than hydrogene. A candle having burned out in a veſſel full of atmoſpheric air in contact with lime water, a very ſmall kitten (about 14 days old) was put into the ſame portion of air; after the death of this kitten, which did not happen in leſs than 3 hours,

hours, the fellow of the three preceding rabbits was introduced: the following were the appearances.

Minutes.	
1	Breath ſhort—turns rounds.
3	In no great diſtreſs, breath ſhort.
5	The ſame.
7	Breath ſhorter.
10	Reſpiration apparently more laborious.
12	Taken out—very ſoon recovered—a candle plunged into the veſſel was immediately extinguiſhed.

EXPERIMENT V. — RABBIT X. *again, at the interval of ſeveral days in hydrogene air.*

Minutes.	Seconds.	
——	——	At firſt very tranquil.
2	5	Snuffs for air round the ſide of the veſſel.
4	0	Reclined almoſt on its ſide.
5	30	Breathes thick—very weak.
6	10	Taken out, breathing thick.
7	10	Could ſit.
8	0	Could move, tho' ſtill weak.
9	30	As uſual.

EXPERIMENT VI. RABBIT X. *a third time.*

At the interval of two days—recent hydrocarbonate, prepared without ſuperfluous ſteam.

——	——	Diſtreſſed the moment of immerſion.

Min.	*Sec.*	
0	20	Scratched the veſſel furiouſly.
0	25	Fell on its ſide.
0	35	Motionleſs and inſenſible—taken out.
——	——	Lay as dead ſome time; finally recovered.

Another rabbit of the ſame brood, (before immerſion in water, viſible much affected with fear) ſtruggled with ſtrength for a minute and an half. At the end of two minutes, forty ſeconds, it moved; in three minutes was taken out, but did not recover.

Should theſe experiments be repeated by a perſon, careful to procure his elaſtic fluids free from offenſive acid fumes, the diſtinctneſs of the phænomena I obſerved, perſuades me that their general reſult will be confirmed. Of ſome readers, whom the importance of the ſubject may lead to take up this pamphlet, the curioſity will, I fear, be repreſſed by ſenſations, ariſing from the idea of pain endured by the animals. In a few caſes, the torture which was inflicted was exceedingly repugnant to my own feelings; and for this reaſon, I have left one ſeries of experiments (Sect. vii.) more incomplete than I could eaſily have rendered it. Againſt drowning, an imputation of cruelty will hardly lie: Animals, deſtined to this death, may juſt as well drown for the inſtruction of the phyſician. Beſides, did not accuſtomed acts of outrage and injuſtice daily paſs uncenſured, I know not how he who feeds upon the fleſh of a ſlaughtered animal can conſiſtently con-

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demn investigations, seriously tending to restore or preserve health, though conducted at the expence of the life and ease of animals, unable to resist the power of man. I wish, with all my heart, I could prove that morose writer in the wrong, who has called the Earth A VAST FIELD OF BATTLE, where creature, for preservation, preys upon creature, or tortures its fellow in pursuit of pleasure.

Two kittens immersed, one in carbonic acid, the other in hydrogene air, afforded a similar result; that is, the carbonic acid appeared full three times as deleterious as hydrogene.

Finally, to render the difference again more distinct, two equal quantities of atmospheric, were successively mixed with an equal bulk of carbonic acid, and of hydrogene, air. A rabbit (S) being put into the mixture of atmospheric and carbonic acid air; the following observations were made.

	Minutes.	
In	2	Appeared weak.
	4	Has been couchant for 2 minutes.
	6	Very still.
	11	Respiration more laborious.
	26	Extremely weak; seems ready to fall on one side; scarce alive.
	43	Quite dead.—After the 2d minute it never rose—death very lingering.

A fellow rabbit, T, in atmospheric and hydrogene air, seemed much less distressed at first; rubbed its fore-feet after it had continued in the vessel 40 minutes,

nutes, and performed ſeveral other actions; much of the time it ſat, that is, it continued erect before. Even at the laſt, no diſtreſs, except quick reſpiration, was obſervable.

In 48 minutes it was taken out; it now ſtood firm; and though unwilling to move; was capable, when urged forward, of advancing, without ſtaggering, or any ſign of great debility. In appearance it had ſuffered leſs in 48 than its fellow in 15 minutes.

XI.—*How hydrocarbonate air affects venous blood.*

Two fouls were ſtrangled and a rabbit was drowned while their fellows were immerſed in hydrocarbonate air. In all theſe laſt the veins appeared of a brightiſh red colour! the liver and heart (which was perfectly irritable) were alſo of a bright colour. In the others the liver was dark as uſual; and the heart pale. In the hydrocarbonated rabbit the fleſh was univerſally of a light lively red. The blood from the *venà cava* had the ſame brightneſs; it coagulated about as ſoon as the livid blood of the ſtrangled fouls and drowned rabbit. The boiled fleſh of all the fowls had much the ſame taſte and toughneſs. The muſcles of the lower extremities of the hydrocarbonated fowls were of a lively red. The boiled fleſh of the h. rabbit had a pink hue. Of two equal fowls one was put into hydrocarbonate and one into carbonic acid air; the former was ruddy throughout, as was well ſeen in the heart cut acroſs. In the fowl put into c. acid air nothing of this bright red colour appeared. The liver I thought paler than in ſtrangled fowls: but I had not one at hand for immediate compariſon. Of this laſt h. fowl the wings and breaſt were brown, and the thighs reddiſh.

XII. *Reflections on the preceding facts.*

The attentive reader muſt have ſeen, even in the reſult of theſe ſimple extemporaneous experiments, indubitable proofs of the power on factitious airs variouſly to affect the living frame. It appears that oxygene air, when inſpired pure, or nearly ſo, increaſes the motions ſo as to produce dangerous or mortal inflammation; that by reddening the blood, it brightens the colour of the ſolid parts; even that of the liver, which anatomy ſhews to be the leaſt likely of all the ſolids to be affected by any change of the arterial blood; that it renders animals leſs capable of being drowned or deſtroyed by cold; that it is expended in muſcular motion, ſince animals that have exerted themſelves violently, immediately before confinement in a given quantity of atmoſpheric air, or during confinement, ſooneſt exhauſt it of oxygene; and that, when it is blown into dogs, in the manner veal is blown up by butchers, it produces a remarkable degree of vivacity. Theſe facts, compared with ſome of the obſervations, which will be given in the next paragraph, will prove of uſe in directing us how to apply this air properly as a remedy; eſpecially as they will appear to have been confirmed ſince their firſt publication by obſervations on the ſick.

Between unreſpirable airs, there ſeems a remarkable difference in their power to produce inſenſibility and death. Hydrogene appears the leaſt noxious, both when inſpired alone, or mixed with atmoſpheric air. Azote probably differs little from hydrogene. Hydrocarbonate ſeems extremely deleterious; Mr. Watt gives evidence of this in the human ſpecies. I can add a ſimilar obſervation. A perſon in confirmed

firmed consumption breathed a quantity of hydrocarbonate, mixed with 4 times its bulk of atmospheric air: he became very sick, or rather vertiginous; the pulse was much quickened, and the extremities became very cold. The patient finding an abatement of pain in his side, and of dyspnoea, returned for another dose. The operator, a chemist of great skill, thinking the former dose too strong, mixed 50 c. inches of hydrocarbonate with 600 of atmospheric air. This was respired without any sensible effect. In a quarter of an hour, 100 c. i. of hydrocarbonate were mixed with 600 of atmospheric air. The patient breathed at twice about two-thirds of this mixture, when he was desired to desist. Soon afterwards he became vertiginous and nearly insensible, his pulse at one period being nearly imperceptible; the sphincter of the bladder was relaxed; after his recovery, he was again very cold—"intensely cold to his own feelings" was his expression—as well as to the touch. After getting into his carriage, he fainted; and his pulse for several hours continued quicker and weaker than before. The operator having observed, that when much water is added to red-hot charcoal, carbonic acid air is copiously produced, in the preparation of this last portion of air, had added so little water, that no superfluous steam at all came over; hence it was as pure as can be made: being also newly prepared, it retained all the charcoal it had carried up; of which it is well known to deposit part on standing. This might lead to conjecture, that the greater deleterious power of heavy inflammable air from water and hot charcoal (hydrocarbonate) compared with that of light inflammable air, depends on the

the facility of its combination, or at leaſt of the charcoal it contains with the oxygene of the blood; in conſequence of which, it ſpeedily diſarms the ſyſtem of its moving principle. This opinion ſeems countenanced by the effect of nitrous air, which more quickly deſtroys life than any of thoſe above-mentioned, and which is well-known very readily to combine with oxygene. Death, in this caſe, might be more inſtantaneous, from the inſtantaneous production of an highly corroſive acid (nitrous acid) and its application to the whole ſurface of the lungs. But for the rapid effect of carbonic acid air, and the appearances in Sect. XI, I can aſſign no plauſible reaſon; nor does the above hypotheſis ſuit the facts in Sect. XI; which, with thoſe in Sect. X, refute the opinion of thoſe eminent philoſophers, who have of late ſuppoſed that water and ſeveral bland unreſpirable airs occaſion death, ſimply by the excluſion of the oxygene of the atmoſphere. Their action is certainly unequal; and I preſume, recovery from aſphyxia in water (when but little goes down the wind-pipe), hydrogene air, azote, or from ſtrangulation (where no material organic injury is produced), will be much more eaſy than from aſphyxia, occaſioned by other unreſpirable mediums.

Experiments to diſcover the effects of the long continued action of aeri-form ſubſtances, would be much more curious than ſuch as I have made. They would thus, in all probability, more deeply and permanently affect the living ſyſtem. If, for inſtance, an animal were kept in an atmoſphere containing $\frac{20}{100}$ $\frac{24}{100}$ of oxygene or ſtill leſs, it would perhaps be affected by the ſea-ſcurvy. The muſcular fibres, at leaſt, and the ſolids in general would in all probability be found weak,

tender

tender, or eaſy to be torn. Again, if three equal growing animals were kept, one in the atmoſphere, the other in air of an higher, the third of a lower, ſtandard, and in all other reſpects treated alike; ſome conſiderable difference would perhaps be obſerved in their growth and vigour.—By frequent immerſion in water, the aſſociation between the movements of the heart and lungs might perhaps be diſſolved; and an animal be inured to live commodiouſly for any time under water. If ſome plan, ſimilar to that which I have ventured to propoſe, ſhould be executed, ſuch proceſſes of inveſtigation ought to be carried on in the inſtitution.

XIII.—*Some effects of the inſpiration of hydrogene, to elucidate the reſult of the foregoing experiments.*

"When an animal is immerſed in water, *his pulſe becomes weak and frequent*, he feels an anxiety about his "breaſt, and ſtruggles to relieve it: in theſe ſtruggles, "he riſes towards the ſurface of the water, and throws "out a quantity of air from his lungs. After this, "*his anxiety increaſes, his pulſe becomes weaker*; the "ſtruggles are renewed with more violence; he riſes "towards the ſurface again; throws out more air from "his lungs, and makes ſeveral efforts to inſpire; and "in ſome of theſe efforts, a quantity of water com-"monly paſſes into his mouth; *his ſkin then becomes* "*blue, particularly about the face and lips*; *his pulſe* "*gradually ceaſes*; *the ſphincters are relaxed*; he falls "down without ſenſation, and without motion." *(Dr. Goodwyn, l. c. pp 3, 4.)* This deſcription of drowning in water applies, as far as the circumſtances admit of compariſon, to the effects occaſioned by the reſpiration of pure hydrogene. I have remarked them in a num-

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ber of healthy perſons, who were curious to try how long they could breathe this air. The frequency and debility of pulſe, blueneſs of the lips and coloured parts of the ſkin, were always obſervable in a minute, or a minute and an half. Beſides, dizzineſs was felt, and the eyes have grown dim; in animals, the tranſparent cornea has appeared ſunk and ſhrivelled. Several individuals agree in deſcribing the incipient inſenſibility as highly agreeable. One conſumptive perſon loved to indulge in it; for this purpoſe, contrary to my judgment, he uſed to inſpire a cubic foot of hydrogene at a time. This quantity moſt commonly produced little change in his feelings. Sometimes it brought on almoſt compleat aſphyxia. During this proceſs, I have felt the pulſe nearly obliterated. Afterwards, as he recovered, it was ſenſibly fuller, and ſtronger than before the inſpiration. This fact belongs to a general principle now beginning to be underſtood; when the ordinary powers have been, for a certain time, withheld from the body, they act with greater effect, as holding the fingers to the fire after handling ſnow, occaſions ſevere aching. For this reaſon, whenever air with leſs oxygene is to be inſpired, it would ſeem more advantageous to employ for a long time an atmoſphere little reduced, than one ſo low that it can only be breathed for a ſhort time.

An obſervation the patient juſt mentioned made upon himſelf, ſeems to ſhew the neceſſity of oxygene to muſcular action. Judging, from his feelings, that he was perfectly recruited after his doſe of pure hydrogene, he has riſen from his ſopha with an intention to walk about his apartment, but has been ſurpriſed on riſing, to find himſelf incapable of advancing three

ſteps,

ſteps, till he had reſted ſome time longer. In this caſe, was not the ſtore of looſely combined oxygene, laid in before, expended during the inſpiration of the hydrogene, by thoſe motions which are perpetually going on in the ſyſtem? Did it not require ſome time to replace the neceſſary portion in the muſcles, remote from the heart and lungs?

XIV.—*Some particulars relative to oxygene, ſupplemental to the preceding experiments.*

The celebrated Dr. Ingenhouſz in a letter dated Auguſt 4th 1794, mentions to me a very curious experiment, "which," ſays he, "if it be a real fact, "throws a great deal of light upon your ſyſtem; it is "this:—Bliſter your finger, ſo as to lay bare the na-"ked and ſenſible ſkin. The contact of air will pro-"duce pain: put your finger into vital air, and this "will give more pain; introduce it into fixed or azo-"tic air, and the pain will diminiſh or ceaſe." Dr. Webſter, he adds, was informed of theſe circumſtances, by a Frenchman, whoſe name does not appear: I had often heard them indiſtinctly related; and it is rather ſurpriſing that the fact has not been aſcertained. Much of the art of modern ſurgery conſiſts in keeping the air from wounds and ſome kinds of ulcers: and this fact, if the account be true, pretty deciſively ſhews which ingredient of the atmoſphere is injurious.

I applied a bliſter an inch long, and half an inch broad, to the back of the third finger of the left hand. When the pain from the action of the cantharides had entirely ceaſed, I cut away the ſcarf-ſkin of the veſication and was ſenſible, the moment the air was admitted, of a ſharp ſmarting pain. This did not continue

fo fevere; but the expofed true fkin fenfibly fmarted. Upon tying the neck of a bladder, containing carbonic acid air from heated chalk, round the root of the finger, the pain very foon fubfided. While I kept my finger in carbonic acid air, which was near half an hour, I fhould not have known it had received any injury. On taking it out, the furface had a whitifh appearance — Was this from the beginning of the formation of epidermis? — In the air — the experiment was made in a warm temperature — the fmarting returned; in an hour the expofed fkin was painful and looked angry, as the expreffion is: I again enclofed it in carbonic acid air; in fix minutes I felt no more pain. After feveral hours I again removed the bladder, and foon felt the fmarting return.

During the hour after my finger had been for the firft time taken out of the bladder, I had introduced it into a phial of oxygene air, for a few minutes, but was not fenfible of increafe of pain; nor can I fay that the rednefs and angry appearance was owing to this circumftance.

The following experiments were made on three different perfons: — 1. The raifed epidermis of a bliftered finger, after all action of the cantharides had ceafed, was cut away in carbonic acid air. No pain was felt. The atmofpheric air flowly mixed with the other in the glafs cylinder, as I found by the dull manner in which a candle after fome minutes burned in it; and now fome flight pain was felt. The finger being put into oxygene air, a fmarting came on, and lafted 20 minutes; but then became lefs The finger was next put into air containing alkaline fumes; and the pain was much feverer than ever. — 2. A fecond

blifter

blister being opened in the air, smarting pain came on. In a bladder of fixed air it soon went off. — 3. The epidermis was cut off from a blister on my own finger, which I instantly plunged into oxygene air: it felt as when salt is sprinkled on a cut: and the pain was, I am pretty sure, more severe than when my former blister was opened in the atmosphere. In carbonic acid air the pain in two minutes quite subsided, and returned when I exposed the bare skin to the atmosphere.

At Oxford, in 1790, I had proposed to a distressed negro, to try to whiten part of his skin with oxygenated marine acid air. He was to exhibit the appearance, if it should be curious, for the relief of his family. His arm was introduced into a large jar full of this air, and the back of his fingers lay in some water impregnated with it at the bottom of the vessel. It was perceived that he had ulcerations from the itch between his fingers: and this made me very cautious about the experiments. In 12 minutes he complained of severe pain from the ulcers, and the arm was withdrawn. The back of his fingers had acquired an appearance as if white lead paint had been laid upon them, but this did not prove permanent. A lock of his hair was whitened by this acid. Next day the ulcers became extremely painful, and the hand swelled from the inflammation: this deterred him from a continuance of the experiment after he was cured of his complaint. You cannot safely impute the effect of this powerfully stimulating acid to its oxygene alone.

But the fact stated by Dr. Ingenhousz is very agreeable to the common phænomena presented by wounds. Moreover, I have lately seen cancerous patients treated by the application of unrespirable air, with the most astonishing

astonishing succcess. In mentioning to Dr. Black the introduction of factitious airs into the BATH hospital, as a source of hope, I did not so soon expect an event which ages and nations have desired in vain. Observations, extremely analogous to the experiments just related, were there made during the course of the treatment. See Dr. Ewart's pamphlet. Should it be invidiously observed by any reader of this narrative that something similar had been tried before, it may be truly replied, that these trials were rather discouragements to the new application of elastic fluids; and that failure in former instances enhances the merit of the recent method. Mr. Magellan's case seems never to have been much known in England.

It seems not improbable, that on certain ill-conditioned ulcers, oxygene externally applied has a salutary effect, by occasioning greater action, both of the vessels which throw out the copious thin discharge, and of the absorbents. Many substances, usually applied to such ulcers with success, as metallic salts, contain much oxygene, and some are most highly charged with this principle, as the red oxyds of metals. The following intelligence, if authentic, adds confirmation to this opinion, and may prove useful. A few months ago, I was struck with the frequency of scrophulous tumours among the poor of the county of Longford, in Ireland. Supposing that necessity might have occasioned the trial of many methods of cure, I enquired whether the people there had not some peculiar domestic practices in such complaints. A physician referred me to a simple but very reputable old farmer, as remarkably successful in scrophulous sores. With this person I had an interview. In his practice, he had no view to gain; and that, in his principles, he had nothing of empirical imposture, he convinced me

by

by at once difclofing his whole fecret. He had himfelf, many years ago, an ulceration of the fubmaxillary glands: This, after various unfuccefsful applications, was healed by a ruftic practitioner like himfelf. He obtained a knowledge of the remedy, by which, during a long life, he affured me he had himfelf healed many fuch ulcers of the glands about the jaws. He was fo little fpeculative, as never to have attempted the cure of an obftinate fore in any other feat. That he might effectually inftruct me, he brought fpecimens of his fimples. They were the leaves and ftalks of wood-forrel *(oxalis acetofella)*, and the root of meadow-fweet *(fpiraea ulmaria)*. The forrel he prepares by wrapping it in a cabbage leaf, and macerating it by its own juices in warm peat afhes. This pulp is applied as a poultice to the ulcer, and left 24 hours; the application of forrel is four times repeated; then the roots of the meadow-fweet, bruifed and mixed with the four head of efflorfcence that appears on butter-milk, left in the churn, are ufed in the fame manner, till the fore heals, which I was told always fpeedily happens; often in two or three weeks.

The following extract of a letter from Mr. Edgeworth, of Edgeworthftown, contains fome fupplementary information, and will probably add fo much to the credit of my information, as to obtain a trial for the remedy.

"I have learned from Mr. Mills, that when he was about eight and twenty, he had two large fcrophulous fwellings in his neck, one under each ear, near the jaw; the marks they had left he fhewed me. He was attended by a furgeon in the neighbourhood for fome weeks, without receiving any benefit. A farmer, with whom

whom he was acquainted, recommended the application he mentioned to you, by which he was completely cured. The man told him the names and quantities of the ſeveral ingredients, when he applied them, but did not till ſome years afterwards (when he was leaving this country for America) apprize him that the *myſtery of the cure* (this was his expreſſion) depends entirely upon the ſorrel. This perſon had predicted to Mills, that one of the ſores, which had been lanced, would not heal ſo ſoon as that which had ſuppurated of itſelf; and he found this to be true. Whilſt he had ſcrophulous ſwellings, he was weak and unhealthy; from the time the wounds were healed, he has been ſtrong and active; he is now eighty; and whilſt he was relating theſe circumſtances to me this evening, he kept pace with my horſe up hill, for half a mile, without any apparent effort. I mention this, becauſe it is a common opinion (I ſuppoſe a vulgar error) that healing ſuch ſores is prejudiaial to the general health. He has applied this remedy to upwards of an hundred different perſons, every one of whom have been cured. — Seven years ago I remember having ſeen his ſon, who rents a conſiderable farm from me, with an enormous ſcrophulous ſwelling on his neck; he was in great pain, was weak, and emaciated; he was too impatient to wait for a ſuppuration of the ſwelling, and would have the plaiſter applied to it whilſt it was unbroken; the cure was protracted, but it was effectual; he has had no return of the complaint; a ſlight inequality of ſurface ſtill remains on his neck; Mr. Mills has communicated his recipe to ſeveral, and in particular to a very intelligent perſon in this neighbourhood, who has employed it with unfailing ſucceſs. All the patients complain of the ſeverity of the appli-

cation;

cation; and in every ulcer to which it is applied, there takes place a remarkable change from a dead pale to a bright ſcarlet colour." *July* 17, 1794.

This change of colour indicates communication of oxygene, which perhaps the oxalic acid of the ſorrel contains in ſuch a ſtate of combination as eaſily to part with a portion. Now Dr. Darwin, in his ZOONOMIA, attributes ſchrophulous ſwellings of the glands to inirritability, which, as I have conjectured, may ariſe from a certain deficiency of oxygene. Theſe principles would ſupply an obvious theory, were we but certain of our facts. If however, as the preceding account implies, ſorrel produces detumeſcence of the glands before ſuppuration, its application will be, I ſuppoſe, a more eligible practice than any now in uſe. Writers in the Materia Medica may have applied *deobſtruent* — their word of courſe — to this plant, but I remember no particular commemoration of its virtue in ſcrophula. Murray, a compiler of extenſive reading has nothing to this purpoſe. — (*Apparat. Medicam.* III. 492-9). —— Since the ſecond edition of this pamphlet, the Rev. Joſeph Townſhend has ſucceſsfully applied the ſorrel to ſcrophulous ulcers, of which trial an account will appear in the 2nd vol. of his *Guide to Health.* I ſuppoſe juice of lemon, more or leſs diluted, would produce the ſame effect.

XV. — *Of the preparation of atmoſpheres of different ſtandards.*

Perſpicuity in the directions, which cannot for all readers be attained in *reaſonings*, being a principal object

object in the present pamphlet, it may be useful, before I proceed, to exhibit a view of those mixtures which furnish atmospheres of an higher or lower standard, than the common air. By *an higher standard*, I mean more than 28 parts of oxygene in 100; by *a lower standard*, less. For the sake of brevity, we might say, *air of the standard of thirty six*, instead of " air containing thirty-six parts of oxygene in an hundred parts."

Mr. Watt's hydraulic bellows furnish the means of throwing any proportions you please of the different airs into the common reservoir. I have found a small spare hydraulic bellows—of the contents of a gallon for instance—highly useful in adjusting the proportion of atmospheric air. It may be larger; but when small, it is very *handy*. The effect, as far as can be ever useful in practice, is shewn in the following tables:

Change of the standard of atmospheric air, by addition of other airs.

The standard of atmospheric air being 28 oxygene 72 azote, it is altered in this manner, by the addition of successive equal parts of atmospheric to one of oxygene: Small fractions are neglected.

		Oxygene.	Azotic.
1 part of atmospheric	to 1 of oxygene -	64 -	36
2 of atm. - -	to do. - -	52 -	48
3 do. - -	to do. - -	46 -	54
4 do. - -	to do. - -	42 -	58
5 do. - -	to do. - -	40 -	60
6 do. - -	to do. - -	38 -	62
7 do. - -	to do. - -	37 -	63

3 do.

8 do.	- -	to do.	- - 36	- 64
9 do.	- -	to do.	- - 35	- 65
10 do.	- -	to do.	- - 34½	- 65½
11 do.	- -	to do.	- - 34	- 66
19 do.	- -	to do.	- - 30½	- 69½

The ſtandard is altered in the following manner by addition of ſucceſſive equal parts of oxygene to one of atmoſpheric air:

			Oxygene.	*Azotic.*
2 oxygene	- -	to 1 atmoſpheric	76	- 24
3 oxygene	- -	to do. - -	81	- 19
4 do.	- -	to do. - -	85	- 15
5 do.	- -	to do. - -	88	- 12

Reſpecting theſe two tables, it is to be obſerved, that the moſt ſkilful chemiſts have never been able to obtain oxygene air quite pure; it may therefore be allowed, that in ſuch as will commonly be prepared, not more than 85 parts in 100 will be pure oxygene; unleſs it be prepared from good mangancſe and rectified vitriolic acid; of this, waſhed in lime-water, not 10 parts in 100 will be unreſpirable. The unreſpirable air, with tolerable care, will be obtained free from oxygene. The following proportions, therefore, will be more exact than the foregoing:

Effect of the addition of different portions of atmoſpheric to one of unreſpirable air.

			Oxygene.	*Unreſpir.*
1 atmoſpheric	- -	to 1 unreſpirable,	14	- 86
2 do.	- -	to do. - -	19	- 81
3 do.	- -	to do. - -	21	- 79

4 do.

4 do.	- -	to do.	- -	22 -	78
5 do.	- -	to do.	- -	23 -	77
6 do.	- -	to do.	- -	24 -	76
7 do.	- -	to do.	- -	24 -	76
8 do.	- -	to do.	- -	25 -	75
9 do.	- -	to do.	- -	25 -	75
10 do.	- -	to do.	- -	25½ -	74½

Effect of the addition of different portions of unrespirable airs to one of atmospheric.

1 atmospheric	- -	to 2 unrespirable	9 -	91
1 do.	- -	to 3 do. -	7 -	93
1 do.	- -	to 4 do. -	5½ -	94¼
1 do.	- -	to 5 do. -	5 -	95

XVI.—*Of the method of procuring elastic fluids.*

To procure a dose of factitious air by means of Mr. Watt's apparatus will, I think, be found more easy than to dress a joint of meat. In several instances under my eye, a servant of plain understanding has managed the apparatus perfectly: in one a maid servant has proved quite equal to the task. When inexperienced operators have failed, it has been from setting the water to drop before the charge in the furnace was red-hot, or letting it drop too fast afterwards. Hence they get steam instead of air. When the joints are made tight, and the heat is proper, and the water does not drop too fast, the operation proceeds perfectly. Mr. Watt gives a sufficient variety of lutes. A strip of oiled silk bound fast round a joint, alone makes a good lute, so does a strip of bladder.

I was for some time anxious concerning oxygene air. Expecting this would be full as extensively useful in medicine, as any unrespirable air, I wished for a method

method equally ſimple of procuring it. The manganeſe from the Mendip hills gives 1. azotic, 2. oxygene, 3. azotic with carbonic acid air; ſo that the whole product is not much ſuperior to the atmoſphere. I feared leſt it ſhould be found difficult to catch the beſt part of the produce. At the ſuggeſtion of Mr. Hermbſtaedt and Mr. Chaptal I turned my attention to the ſolution of manganeſe in vitriolic acid. Mr. Hermbſtaedt had found a pound of either the Ileſeld or Ilmenau manganeſe, with ſtrong vitriolic acid, to yield 3384 cubic inches of "the beſt oxygene air."—(*Hermſtaedt's Verſuche*, B. II. p. 49.) Mr. Chaptal obtained full as much from French manganeſe. I procured 150---200 c. i. of oxygene air (which by the nitrous teſt proved excellent) from oil of vitriol and 1 oz. Exeter manganeſe. But when I came to make experiments with a view to diſcover a proper method for common practice, I perceived that this proceſs was highly objectionable. The firſt portions of air procured by means of the oil of vitriol of commerce contained much oxygenated marine acid air—a ſpecies of elaſtic fluid exceedingly deleterious and irritating to the lungs. This happened becauſe ordinary oil of vitriol is contaminated with muriatic acid. Beſides, as the acid of vitriol will itſelf be carried up by the heat neceſſary to extricate the air by this operation, the veſſels will ſuffer from corroſion, unleſs troubleſome precautions are employed. The air itſelf too will not eaſily be totally freed from the pernicious acid fumes. Hence, contrary to my firſt intention, I ſhall omit directions for procuring oxygene air from oil of vitriol and manganeſe; they are fortunately become unneceſſary, ſince Mr. Watt's apparatus anſwers incomparably for this alſo, according to his laſt directions.

Exeter

Exeter manganefe is in no refpect preferable to any other, that does not contain much calcareous earth, or fome noxious mineral, which latter is not the cafe with any manganefe I know. To impregnate hydrogene air with zinc, I have thought it fufficient to put a few ounces of zinc (which in the fhops is called *fpeltre*) into the pot, the reft of the charge being of iron.

It may be well to fuffer oxygene air to ftand fome hours before it is ufed, that it may depofit the fufpended particles of manganefe; which however, as far as I have feen or heard, have never been in the fmalleft degree hurtful. — As to the hydrocarbonate, I fully agree with a very judicious correfpondent, that it will be moft powerful when frefh. When the fire-tubes are new, hydrogene will be generated as well as hydrocarbonate.

As there can be no reafonable doubt but the ulcers of the lungs were healed by air from chalk and acids in the cafe of the lady defcribed by Dr. Ewart, and as other refpectable obfervers have feen the fymptoms of confumption alleviated by the fame practice, I have added to this edition the figure of an apparatus for effervefcing mixtures, lefs objectionable in one refpect than I remember to have feen defcribed. It may be ufed as an auxiliary to Mr. Watt's apparatus, but ought in no cafe to be depended on alone. The lower veffel B. *fig*. 1. *pl*. 4, is to contain vitriolic acid or fpirit of falt (muriatic acid) and chalk for carbonic acid air; and either acid with zinc for hydrogene air. The former of thefe mixtures foams much, and the apparatus fhould be placed on a large pewter difh. The oil of vitriol fhould be mixed with 16 or 20 times its bulk of water; and the chalk fhould be pounded and made

into

into ſauſages with water. The veſſel ſhould be filled only to a 4th or 5th part of its height with the materials. It may be made to hold from three to five gallons. Into the ſmall bucket C of the capital may be put ſpirits of hartſhorn to the depth of an inch, the bucket itſelf being four inches deep. The fumes of the ſpirit of hartſhorn will areſt the acid ſpray, and prevent its paſſing down the long tube. The capital A is to be ſet in the groove at the top of the veſſel B, which is to be filled with water. This groove ſhould be more than an inch deep. The tube may then be turned towards the patient's face. Spirit of ſalt diluted juſt enough to diſſolve the chalk with moderate briſkneſs is better than vitriolic acid for a continued efferveſcence; but it is more expenſive; for this acid the chalk need only be broken into lumps of the ſize of a walnut. The ſpirit of hartſhorn ſhould be renewed whenever it has conſiderably loſt of its pungent ſmell.

If hydrogene air be wanted, the veſſel B may be filled to a greater height, becauſe the ingredients do not foam ſo much. The oil of vitriol in this caſe is not to be ſo much diluted; from 5 to 7 times its bulk of water is ſufficient. But it may always be tried in a glaſs with a bit of zinc beforehand. You will eaſily judge whether your mixture wants acid or the other material according as it begins to act anew when you add a little of one or the other. If you drop in a roll of chalk, for inſtance, and no hiſſing is preceived, it wants acid. The whole apparatus ſhould be japanned, and the inſide alſo be anointed with melted bees wax. I have directed, when it could be done, that the vitriolic acid and water ſhould be boiled together. The

managemen*t*

management of this apparatus is troublefome, as of every other where you want a continued effeverfcence. In pouring thefe acids from veffel to veffel, it is difficult to avoid fome fplafhing, by which holes will be burned in the cloaths. The fumes of muriatic acid foon fpoil polifhed iron furniture.

XVII. — *Cafes in which oxygene air was infpired.*

The cleareft directions for the ufe of factitious airs in medicine will be afforded by a faithful account of the effects they have been already found to produce. I fhall therefore difpofe the clinical obfervations I have to lay before the reader in the beft order I can devife. To thefe obfervations I fhall fubjoin a brief recapitulation; in hopes it may furnifh a more precife idea of the progrefs already made, and contribute towards the accumulation of further knowledge.

Letter from DR. THORNTON.

Feb. 27, 1795. — *Great Ruffel-ftreet.*

DEAR SIR,

I am very happy to hear your propofal for a *pneumatic inftitution* meets with the fupport of fo many eminent phyficians and men of fcience. I wait with the utmoft impatience for its eftablifhment, firmly believing that the experience refulting from it will be of the greateft public utility. The fubjoined cafes will be a great inducement for extending pneumatic remedies in the propofed inftitution to furgery; they will, I truft, operate fomewhat with the public in promoting a fubfcription fufficient for that benevolent purpofe.

The

The firſt caſe will appear to great advantage, as the patient has obligingly permitted me to encloſe to you his journal, which is the faithful picture of his own feelings; he aſſures me, he had not the leaſt knowledge of any part of your *theory* of the operation of vital air, but was induced from ſeeing ſomewhat ſimilar cures performed, to confide himſelf to Mr. Hill, an ingenious ſurgeon, who has been among the firſt to apply theſe new powers to the purpoſes of his profeſſion.

Journal of the Rev. Mr. ATWOOD, *Rector of Saxlingham and Sharrington.* Part I. *Statement of the caſe, and of the effect of the common means of cure.*

" December, 1779.—The left leg has felt for ſome time paſt very heavy; is now much ſwelled; upon preſſure the indentation continues. This was wholly removed in about nine weeks by means of a very tight bandage on the leg, exerciſe, ſpirituous lotions, fumigations, and frictions.—October, 1780. The conſtitution much impaired by the hot climate of Spain; was attacked with jaundice, which yielded to ſlow journies on mules and to oranges.—January, 1785. My health was much deranged during this month, with great debility.—1786 and 1787. The habit much relaxed.—December, 1788. Had violent night ſweats.—January, 1789. Theſe continued to the latter end of this month.—May, 1789. Had a violent inflammatory fever.—Auguſt, 1790. Had an eruption on the ſurface on the body.—1791. During this whole year, experienced great debility.—March, 1792. Was ſeized with an inflammatory fever, attended with delirium.—May, 1792. Had a third attack. My phyſician ordered me ſea-bathing, to remove the extreme

debility

debility which ſucceeded to this fever.—From Auguſt 1792, to February 1793, bathed in the ſea. During this time I had many dreadful ſpaſms in the ſtomach and bowels, accompained with nauſea and vomiting. Theſe were the forerunners of the diſeaſe, which has ſince affected my left leg.—January, 1793. There appeared a *mahogany coloured* ſwelling in the left ancle of the left leg, which kept up an inceſſant gnawing pain. —July, 1793. This hardneſs was attempted to be eat away with cauſtic; but it produced only an ulcer of a very unfavourable aſpect.—September, 1793. I placed myſelf under a moſt ſkilful ſurgeon at Norwich, who applied fomentation, unguents, &c. but without any material benefit.—November, 1793. Though a cripple, was enjoined regular exerciſe. The ulcer, however, ſtill contiued increaſing. January, 1794. A *new enemy* more formidable than the other made its appearance. It had the ſame *dark mahogany colour*, and the ſame *unconquerable hardneſs*. By degrees this formed into a dreadful ulcer, which increaſed daily.— March, 1794.— Came to London, and placed myſelf under a ſurgeon of great eminence. Was attended by him daily with unremitting attention. Twice did he employ the lapis infernalis, but theſe ulcers ſeemed to reſiſt every application. My conſtitution being extremely debilitated, with loſs of appetite; want of ſound ſleep; and the mind exceedingly irritable, ſea-bathing was once more enjoined.—From June 14, to October 18, bathed in the ſea.—June 27. Mortification took place. The uſual methods, bark in great quantities, port wine, and yeaſt poultices, were had recourſe to. — October 25. Returned to London. The pains in the leg were exceſſive; the fœtor intolerable;

lerable; the ulcers had made great encroachments; frequent naufea at the ftomach; the bark and other medicines were frequently rejected, the breakfaft fometimes, and now and then the dinner; the nights were exceffive bad; ftrength impaired; in fhort every thing was unfavourable. — December. A friend who had feen the whole progrefs of the cafe, afked my furgeon, "what profpect there was of faving the limb." He made no reply, but very gravely fhook his head.

The following letter is here introduced as effential to a complete idea of the cafe.

Barnet, Feb. 25, 1795.

DEAR SIR,

Being accidentally prefent at the firft interview between you, Mr. Hill, and Mr. Atwood, I cannot help expreffing my great *aftonifhment* on finding fo fpeedy a cure has been actually effected in fo defperate a cafe.

The wound, I mean what particularly called my attention at the time, appeared to me to extend *four* inches in longitudinal direction of the mufcles of the leg, and about *three* inches tranfverfely. It was fo *deep* that not only the whole thicknefs of the adipofe membrane was deftroyed, but a confiderable lofs of fubftance had taken place in the mufcular parts themfelves.

The ulcer was in appearance as *ill-conditioned* as I remember to have feen, either in the London hofpital, or in my own practice of near thirty years, affording an ichorous fœtid difcharge, which appeared to inflame the furrounding parts, and which muft therefore have gone on increafing the evil.

 The

The gentleman's habit of body, from his own account, was ſuch (for he had tried bark, ſea-bathing, &c. without benefit) that I confeſs I had not the moſt diſtant idea, that any cure could have been performed, much leſs in ſo ſhort a ſpace of time.

Indeed I think it a great happineſs to mankind in general, that ſuch a remedy as the vital air has been diſcovered, and that men of ſcience are employing it: I am rejoiced to have ſuch proof, that the blood and juices of our fellow creatures can be ſo changed, that we need not *now* deſpair of our patients even in ſituations truly deplorable. I have the honor to be, &c. &c.

(To Dr. Thornton.) JOHN CORP.

PART II. *of* Mr. ATWOOD'S *Journal, beginning the day before the inhalation of vital air.*

December 13. Got up with a peculiar ſenſation of weight and pain in the leg; a ſenſe of nauſea at the ſtomach; and no inclination for breakfaſt; ſpirits oppreſſed; and the mind irritable; when endeavouring to walk, felt great pain; the large ulcer in the leg looked of a blackiſh hue in places; a probe being thruſt into one part of the ulcer, I had not the leaſt ſenſation in that part; yeaſt poultices were talked of; had no appetite for dinner; felt very much indiſpoſed towards the evening; no inclination for ſupper; had a ſenſe of chillineſs on firſt getting into bed, ſucceeded by hot palms; paſſed as uſual a bad night, with perturbed ſleep; awoke at two o'clock with ſharp and burning pains in the leg, which continued until five in the morning; doſed till nine. — December 14. Got

up

up with naufea at the ftomach; and a fenfe of langour; no appetite for breakfaft; fpirits exceedingly oppreffed; for the firft time inhaled the VITAL AIR diluted with a portion of atmofp heric; had a pleafurable glow at the time; felt an a ppetite for dinner, and my friends obferved my cheeks did not flufh after dinner, as heretofore; my fpirits, which were fomewhat better during the day, funk towards the evening; no inclination for fupper; paffed a very indifferent night. — December 15. Got up but without a fenfe of naufea; had a flight inclination for breakfaft; perfect eafe in the leg; inhaled again the vital air; felt a great appetite for dinner, and a peculiar pleafurable lightnefs after dinner, as if no fuftenance had been thrown in; with a flow of fpirits; and a ftrange idea of being able to mount a horfe, and ride as faft as peo- in health; appetite for fupper; paffed the fweeteft night! fuch as I am fure I have not enjoyed thefe four years. — December 16. Got up quite refrefhed, without the leaft fenfe of naufea at the ftomach; a great inclination for breakfaft; fpirits unufually elated; took the vital air; felt a genial glow during the whole day; great appetite for dinner; walked with agility and without pain; the wound however appeared unfavorable to-day; appetite for fupper; a good night; awoke with a thick clammy perfpiration. — December 17. Spirits much depreffed; no inclination for breakfaft; mind very irritable; much pain in the wound; inhaled the vital air; the wound threw off *nine floughs* this day; a flight appetite for dinner; the fpirits recovered towards the evening; inclination for fupper; had a found night's reft. — December 18. Appetite for breakfaft; inhaled the vital air; a fenfe

of

of glow, which extended even to the fingers ends; the muſcular powers were evidently increaſed; walked with ſlight, or no pain.—December 19. The wound for the firſt time diſcharged *real pus*; had the *ſenſation*, if the expreſſion can be allowed, of *perfect health*, never experienced before this week; ſleep very ſound; pains in the leg towards morning.—Dec. 20. Got up with great ſpirits; inhaled the vital air; the wound diſcharged a great quantity of real pus; a craving for dinner; felt no longer an inclination for much wine, and after four glaſſes, had the ſame ſatisfaction, as three pints uſed formerly to produce; porter was now rather coveted; ſpirits elevated in an extraordinary degree, which together with a genial ſummer's warmth continued from four to nine in the evening, and then ſubſided to humbler ſpirits; ſlept profoundly from ten to four, which, with the morning doze, made me get up ſufficiently refreſhed; tranſitory pains in the leg.—December 21. A fine appearance of *white edges* in the wounds; great appetite for dinner; an univerſal glow in bed, accompanied with perſpiration; ſharp twitching in the leg.—December 22. Appetite for breakfaſt; inhaled the vital air; the wound ſtill kept on a great diſcharge of laudable pus; no appetite for dinner; in the evening a peculiar ſenſe of weight and uneaſineſs in the leg; a great liſtleſsneſs in the evening; much irritation in the leg, particularly in the ulcer, with much *itching* round the part; but an indifferent night.—December 23. Spirits oppreſſed; inhaled the vital air; returned home without much inclination for dinner; ſpirits rather mended towards evening; enjoyed a good night's reſt. —December 24. Eat a hearty breakfaſt; ſpirits elevated;

vated; walked with eaſe and vigour; a ſurpriſing change for the better had evidently taken place in the wound; appetite for dinner; had a good night.—Chriſtmas day. Still the ſame happy appearance in the wound to day.—December 27. The ulcer looked wonderfully well; was evidently decreaſed in ſize; the diſcharge very favourable; but leſs in quantity; great pain was felt in the ulcer for a quarter of an hour in bed; afterwards fell into a refreſhing ſleep.—December 28. All the appearance of healing; the wound much decreaſed; ſome parts filled up; and the borders of a fine white; the whole leg, which before exhibited a dark purpliſh appearance, wore now the livery of health.—December 29. The cavity of the wound was almoſt filled up; the effects of the vital air operating together with my amendment, produced a conſtant gaiety, as if I had been drinking champagne; enjoyed a profound night's reſt.—December 30 and 31. The ſame ſenſation of perfect health; elevated ſpirits; great appetite; and comfortable ſleep.—New-year's day. Every thing in a good train. My toaſt after dinner was, "*May the introducers of aerial remedies meet with that recompence from their country, which they ſo amply deſerve.*"

[This toaſt from motives of delicacy I would have omitted, but I thought it my duty to tranſmit you the journal entire as written by the author. R. I. T.]

It was applauded and unanimouſly drank.—Jan. 1, 2, 3, 4, 5, 6, 7. As on the preceding days, with evident and progreſſive amendment in the wound.—January 8. Went to a private concert; before, muſic was diſguſting to me, having no ſpirits to enjoy it; was ſurprized,

ſurprized to find myſelf ſtanding, as I was playing on my violin, without leaning on a chair, at ſeveral different times during the evening, and without the leaſt ſenſation of fatigue or pain.—January 9. The ſmaller ulcer, which of late I have not much noticed, was *healed.*—January 10, 11, 12, Nothing peculiar.—January 13. The old ulcer was this day rubbed hard with a flannel, and the larger ulcer appeared nearly healed.—January 14. Walked with great vigour; the larger ulcer was rapidly *ſkinning over*; appetite good; ſpirits good; and ſleep the ſame.—January 17. Notwithſtanding the ſeaſon, the moſt inclement I remember, the ulcer was completely *ſkinned over*: and my body ſeemed fortified againſt cold."

Here ends the journal. I have to add that on the 25th of February, the family received a letter from Mr. Attwood, from on board the Stately, of which ſhip he was made chaplain. He was then in perfect health and ſpirits.

Letter of MR. ATWOOD *to* DR. THORNTON.

Symon's Town, Cape of Good Hope,
15th Sept. 1795.

MY DEAR SIR,

I ardently wiſh to enjoy the happineſs of ſeeing you again. You have performed wonders on my peculiar conſtitution, radically ſtrong and powerful, but which was haſtening to a rapid diſſolution, till revived and renovated by the oxygen. My ſtrength is encreaſing every day with a firmneſs of nerve and calmneſs of ſpirits never experienced before. I perſevere in an uniform plan of riſing at ſix, walking till eight, ſub-

ſiſting

fisting on soup, fish, and vegetables, and going to bed at ten. Wine is left off (except three glasses of white Teneriffe wine at dinner), as well as meat. By these means I feel the habit cool and braced, with a capability of taking powerful exercise, without the least fatigue. The fleecy waistcoasts are absolutely necessary in this climate, as heavy dews and cold winds at sunset often succeed the heat of the day. The prevailing disorders of course are fevers, flux, and dysentery, which destroy many patients; except this sudden check to perspiration the climate is delicious, but in my opinion not so hot as Lisbon. Last June (December here), green peas were in blossom.

With the greatest esteem,

I remain, &c.

T. E. ATWOOD.

There are two other cures, which deserve your particular attention, as the persons were previously in the best hands, and as they serve in some degree to confirm your ideas respecting *herpes*, as depending upon a deficiency of the oxygenous principle.

John Patterson, aged 45, married, has five children; he was formerly a sailor. He had endured much hardship, and at one time lived for nine months wholly on salt provisions. He was subject from the age of fourteen to eruptions on his face. When he came under Mr. Hill's care, I saw him, with a face encrusted over with humours, several purple blotches on his body, many hard scales or scurffs about his arms, and a dark-

coloured

coloured deep ulcer in his leg, which gave out an ichorous and fœtid discharge. He had alſo loſt his ſight near eighteen months. Theſe complicated evils had reſiſted the well-known abilities of Meſſrs. Weſt, Carr, Turnbull, Wathen, Phipps, and others. This caſe being recommended to Mr. Hill by the laſt named gentleman, he gave him the vital air blended with atmoſpheric air, as an alterative of the blood, ſtrengthening his conſtitution with chamomile tea and bark, and Mr. Phipps continued thoſe applications to the eyes, which before the purification of the blood, proved unſucceſsful. After a few weeks inhalation of the modified atmoſphere, I had the ſatisfaction of ſeeing him with a face perfectly clear and ſmooth; large white ſcales fell from his hands and arms; the dark purple ulcers on his body, and the vitiated ulcer in his leg, were healed; and he had ſo far recovered his ſight, that he had at firſt a blue, then a brighter light before him, and after a regular attendance during four months he was able to diſcriminate different objects in the ſtreet.

The ſubject of the next caſe is a widow lady. She had a humour in her right leg, which deprived her of exerciſe, and had produced a painful and diſcoloured ſore in that part of above 18 years ſtanding; 4 years of which time ſhe was attended by Pott, and twenty-ſeven months by Sharp; but neither of theſe eminent ſurgeons were able to effect a cure. After only three week's inhalation of the vital air, a violent itching came on, and in another week this leg was rendered as ſound as the other. Mr. Sharp ſaw this patient at Mr. Hill's, and examined her leg, and was very much delighted. This lady has now continued well near ſix months.

I need

I need not take up your time with Mr. Hill's ſucceſs in other leſs conſpicuous caſes. What I have already related is ſufficient to ſet forth the advantage that will probably ariſe to ſurgery from the introduction and proper application of the pneumatic practice.

I am, &c. &c.

R. I. THORNTON.

P. S. Nothing is ſaid of dreſſings in the above caſes; the uſual modes having been practiſed. The body too was kept open, as occaſion required. — It may be intereſting to add, that the young lady, related to an eminent ſurgeon in London, whoſe caſe is mentioned in a letter of mine which you publiſhed ſome time ago, is now perfectly well. The violent ſpaſmodic ſeizures yielded completely to oxygene air. In the ſame collection I mentioned the caſe of a gentleman far gone in pulmonary conſumption, whoſe ſymptoms were ſurpriſingly mitigated by a lowered atmoſphere. Finding himſelf recruited, he undertook a journey of 140 miles. The hectic fever returned, perhaps in conſequence of his breathing the purer air of the country; and in week after his arrival among his friends, he paid the debt to nature.——R. I. T.

It would be deſirable that Dr. Thornton ſhould fully ſtate the caſe of the lady afflicted by ſpaſms. The cure, I underſtand, was ſo compleat, that it gained the good-will of ſeveral medical friends of the patient to the pneumatic practice. The caſe, if I conceive it rightly, was ſimilar to thoſe deſcribed in Zoonomia, p. 26.

Letter from MR. BARR.

Birmingham, 14th March, 1795.

DEAR SIR,

Having a very high opinion of the effects to be expected from the practice which you have so benevolently promoted; and wishing to encourage farther experiments upon a subject so interesting to humanity, I take the liberty to communicate to you some observations which I have made on the effects of different factitious airs in the cure of scrophula.

About four months ago, a gentleman of this neighbourhood applied to me for advice in the management of a scrophulous ulcer of considerable extent. He had tried various remedies, but had derived no lasting advantage from any of them. When I first visited him he was worn down by a long course of night watching. The deep-seated pain of the arm was so constant and severe, that it had in a great measure deprived him of sleep. His countenance was pale and sickly; his limbs were continually afflicted with aching pains; every exertion, even the most gentle, seemed beyond the measure of his strength, for his body had lost much of its active power, and his mind much of its wonted energy. The discharge from the ulcer was copious, thin, bloody and corrosive; and besides, the whole surface of the sore was so exceedingly irritable that the mildest dressings, applied in the gentlest manner, produced very severe and lasting pain. During the first six weeks of my attendance he regularly took as much Peruvian bark in substance as his stomach and bowels could

could bear; and the ulcer was dreſſed with various emollieent, ſedative, and aſtringent applications, but without any permanent advantage. I then recommended a trial of oxygene air, which was readily complied with. He began by inſpiring four ale quarts diluted with ſixteen of atmoſpheric air twice a day, and gradually increaſed the quantity of oxygene to a cubic foot and a half in the day; by purſuing this plan for about a month, his health was wonderfully improved, but the ulcer ſhewed no diſpoſition to heal. The deep ſeated pain was now entirely removed, but in the ſpace of a few days more, he complained of a burning ſenſation over the whole ſurface of the ſore, ſimilar to the pain ariſing from eriſepelatous inflammation. This unpleaſant ſenſation firſt commenced after inſpiring the whole quantity of oxygene in the ſpace of two hours, which before had been taken in equally divided portions morning and evening. We ſtill purſued our plan, thinking that this new pain might be owing to ſome accidental circumſtance, and that it would ſoon paſs away. But it every day continued to increaſe, and the ulcer began to ſpread wider and wider. The edges became thick and were turned outwards, and the diſcharge became more thin and acrid.

In this ſituation, a local application ſeemed proper. I wiſhed to have applied hydrocarbonate externally to the ulcer, but this from ſome circumſtances of the caſe was not practicable. I then thought to moderate the ſtimulus of the oxygene by a mixture of hydrocarbonate, which Mr. Watt told me would occaſion no chemical change in the two airs. Accordingly a mixture of three parts of oxygene, and one of hydrocarbonate was preſcribed. Four quarts of this mixed air

were

were added to about ſixteen of atmoſpheric, and this quantity inſpired morning and evening. In leſs than a week the burning ſenſation was much diminiſhed, and the ulcer put on a more healing appearance. The mixed air was then increaſed to five quarts, and uſed as before, which produced an increaſe of all the pleaſant ſymptoms. After a few days trial of this proportion of the mixed air ſix quarts were preſcribed. This is the quantity now inſpired morning and evening.

My friend, at preſent, enjoys good health and a good appetite, and feels himſelf as ſtrong as at any former period of his life. The ulcer is now reduced to leſs than half its original ſize, and healing rapidly. There is neither ſuperficial nor deep ſeated pain remaining, and the motion of the joint, and the action of the contiguous muſcles are free and eaſy.

I am, dear Sir, &c. &c.

JOHN BARR.

P.S. The event I will take care to communicate, not doubting but you will find an opportunity of laying it before the public at no great diſtance of time.

Extracts of Letters from Dr. CARMICHAEL.

SIR,

I take the liberty of ſending you the following lines, wherein I ſhall briefly ſtate the effects produced by oxygene upon a perſon affected with amauroſis. My patient I. B. aged 45, began 15 months ſince gradually to loſe his ſight, ſo that about 5 weeks ago he could

ſcarcely

ſcarcely diſtinguiſh a bright fire, or even the glare of the noon day ſun. The right ſide of his face, and half of his tongue, are affected with numbneſs, coldneſs, and loſs of feeling. No other complaint, P. 84. In this ſtate he began on the firſt of Dececember, 1794, to breathe a mixture of 1 part of oxygene obtained by heat from manganeſe, and nine parts of atmoſpheric air, for about the ſpace of five minutes.—2d of December. Has paſted rather a reſtleſs night, and complains much of heat and itching of his neck and ſhoulders. —P. 90. Breathed a mixture of 1 to 7. — 3d. A very reſtleſs night. Complains much of pain in his temples and forehead.—P 98. I directed 8 ounces of blood to be taken from his arm, and afterwards to breathe as yeſterday.—4th. The blood drawn was remarkably dark in appearance, and after ſome time contracted a thin ſuperficial florid cruſt.—P. 88. Paſſed a very reſtleſs evening and night. Head-ache not quite ſo ſevere. Breathed a mixture of 1 part ox. to 4 atm.—7th. Very ſevere head-ache, with temporary loſs of the uſe of his lower extremities. — P. 100. T. white. I directed the venæſection to be repeated to 12 ounces. This day I was afraid to give him any of the modified air. —8th Has paſſed a better night, but feels himſelf low and feeble. — P. 92. Blood dark ; but ſooner than formerly aſſumed a florid cruſt. Inhales as before.—10. Has paſſed two reſtleſs nights, head-ache ſevere, but to uſe his own expreſſion, he feels himſelf " lightſomer." Breathed equal parts.—12th. Both nights he has had very ſevere head ache : and on the 11th was for ſome little time deprived of the power of motion. Numbneſs and coldneſs of his cheek and tongue continued. The irritability of the pupils is not at all increaſed.

Here

Here I thought fit to give up the uſe of the oxygene, as by a contiuuance of it, I muſt confeſs I had fears of inducing a more ſerious diſeaſe than that I was endeavouring to remove or alleviate.—14th December. As I did not think it prudent to perſiſt longer with the ox. I determined to make trial of the hydro-carbonate. I directed for him a mixture containing 1 quart of that ſpecies of factitious air, and 19 of atmoſpheric air, which he inhaled in about ten minutes, reſting at intervals. The ſame quantity was repeated for four ſucceſſive mornings, but no advantage attending this mode, and the vertigo occaſioned by it being troubleſome, I did not wiſh to continue the uſe of it for a longer time. From its diſcontinuance till the evening of the 27th December, he continued much in his uſual way, when he was attacked with apoplexy, from which however he gradually recovered.

Another caſe of Gutta Serena has afforded me an opportunity of trying the virtues of oxygene. This patient, about forty years of age, and of a very irritable habit, has been gradually loſing her ſight for two years paſt; that of one eye is nearly gone, that of the other very indiſtinct. The nerve of the right eye has almoſt entirely loſt its irritability, but the pupil of the left ſtill contracts pretty readily on the approach of light. On inſpection the ſlighteſt degree of cloudineſs towards the external canthus of the left eye may be perceived: and ſhe deſcribes objects as ſeen by the edge of a wall, or of any other interpoſing medium. Every other day, objects appear to her tinged with a yellow hue, and on the intermediate ones of a dark purple. She has the ſame ſenſe of colours in the dark and

when the palpebræ are ſhut: thoſe appearances have ſucceeded each other at the interval of 24 hours, with the utmoſt regularity for ſome months paſt. At times ſhe is ſubject to a total loſs of ſight, which, however, continues but for a few minutes, and ſeldom longer than an hour at a time. Its return is in general accompanied by a conſiderable diſcharge of flatus from the ſtomach, to which ſhe is at all times ſubject. She has tried many remedies, but her ſight, ſhe ſays, has been getting gradually more imperfect.

14th January 1795, I directed her to inhale a mixture, containing 6 quarts of ox. procured from Exeter manganeſe by heat only, and about 18 of common air, which ſhe did in the ſpace of 5 or 6 minutes; and repeated it daily till the 22d.——22. No perceptible change. It was ſuggeſted that it might be better to divide the doſe, and repeat it twice a day, which was accordingly done. I directed her to take 3 quarts of ox. diluted with 18 of atmoſpheric air, forenoons and evenings. As ſhe was rather coſtive, ſhe took occaſionally of the Edinburgh ſtomachic pill.—2d Feb. No advantage attending this method, the doſe was increaſed to 6 quarts of ox. diluted as above, mornings and evenings. On the morning of the ſixth ſhe awoke completely blind, and continned ſo with the exception of a few momentary intervals during the day; ſhe however paſſed a good night, and on the morning of the 7th found her ſight much in the ſame ſtate as it had been on the evening of the 5th. She was a good deal alarmed at the deprivation of ſight for ſo long a period; and as ſhe had not derived any advantage from the uſe of the modified air, I deſired her to diſcontinue it. Her viſion became gradually more imperfect, her

pulſe, during the time ſhe inhaled the modified air, in my opinion, rather acquired tenſion, and the irritability of her ſyſtem was not quite ſo apparent.

S. P. Æt. 17¾.— Complains of univerſal languor and debility, palpitation and difficulty of breathing on the ſlighteſt exertion, eſpecially in going up ſtairs; ſhe is much emaciated, and her ſkin is univerſally pale; her feet and ancles for ſome months paſt have become œdematous toward evening, but more particularly after uſing exerciſe; ſhe complains of pain of her ſtomach, and of frequent cough, attended at times with pain of her ſide. B. regular; app. impaired; pulſe 112. She has never menſtruated, nor had any of the ſymptoms uſually preceding that evacuation. She firſt began to complain about 2½ years ago; ſince which time ſhe has taken different medicines, but without advantage.—Feb. 14, 1795, I directed her to inhale daily a mixture of oxygene and atmoſpheric air, in the proportions of 3 to 17.—18. Modified air produced no evident effect. I directed her 6 quarts of oxygene diluted with 14 of common air.—23d. Since the proportion of oxygene was augmented, her nights have been reſtleſs, and ſhe has complained of general heat. Cough more frequent; p. 125.—26th. Her evenings and nights are ſtill reſtleſs; cough increaſed; pain of her ſtomach not abated; p. from 120 to 125. I directed her to uſe the modified air in the proportions at firſt preſcribed.—March 1. Sleeps better, and in the evenings ſhe thinks that ſhe is leſs hot. Cough leſs frequent, pain of her ſtomach not abated; p. 110.—6th. Pain of her ſtomach leſs troubleſome, appetite mended;

mended; thinks that her ſpirits are higher than uſual; and that ſhe feels leſs fatigue and dyſpnœa on motion, p. 100.—The appearance of her countenance is evidently more healthy; cough much leſs frequent; dyſpnœa and palpitation on motion much relieved; p. 98. ſleeps well; œdema of her feet and ancles ſeldom returns in the evenings, excepting after more than uſual fatigue.—15th. Continues to recover in every reſpect; cough nearly gone; no return of pain of her ſtomach for ſome days; complains ſo little of dyſpnœa and palpitation on motion, that ſhe can walk a mile and upwards without being particularly affected by either, and without much fatigue; p. 89. — 20th. Her general health much improved; the univerſal paleneſs of her ſkin has given way to the natural appearance; and her cheeks, lips and nails have acquired a roſy tinge; p. 81. She has not yet menſtruated, nor has ſhe hitherto had any ſigns indicative of ſuch a change; but as that diſcharge depends upon a certain tone of the arterial ſyſtem in general, I have little doubt but that it will be eſtabliſhed with the complete reſtoration of her health; which deſirable event there is every reaſon to believe is at no great diſtance.

I am, &c. &c.

JOHN CARMICHAEL.

28th. Has uniformly mended in appearance, ſtrength, and in reſpect to her own feelings.—J. C.

Birmingham, March, 1795.

 Extract

Extract of a Letter from DR. PEARSON.

DEAR SIR,

In my little publication, I can ſcarcely call any thing my own, but the obſervations on the *vapour of æther*, of the probable uſe of which in phthiſical caſes, your conſiderations on factitious airs firſt gave me the idea. As the number of conſumptive perſons in this large manufacturing town is deplorably great, I have had frequent opportunities of trying the inhalation of æther in ſuch caſes; and I have the ſatisfaction to ſay that I have found it very beneficial. It abates the hectic heat, relieves and often removes the dyſpnœa, and promotes and improves the expectoration. It ſeems to have ſuch an effect as a mixture of inflammable and fixed air (duly diluted with common air) would have; and where the factitious airs cannot be had, it may be uſed in their ſtead with great advantage.

My trials with inflammable air upon conſumptive patients at the hoſpital here, have, as yet, been too few, and thoſe too much interrupted, to admit of any certain concluſion; but I have lately had a proof of the ſalutary operation of oxygene air in the caſe of a chlorotic girl, Mary Rider, 22 years of age, who has had her menſes ſuppreſſed for the laſt 12 months. After ſhe had taken for many weeks the uſual emmenagogue medicines without experiencing the ſmalleſt benefit, I ordered her, at the end of December, oxygene air, of which ſhe took a large doſe, immediately after it was expelled from oxygene, and before it had time to make any depoſit. Her pulſe, which before was very languid, was conſiderably raiſed by it; and ſhe ſaid ſhe felt a warmth in her cheſt, which con-

tinued

tinued throughout the day, accompanied with head-ach and an uneaſy ſenſation at the ſtomach. At the 2d application, about a fortnight afterwards, ſhe inhaled a ſmaller doſe (viz. two quarts) largely diluted with common air. (This oxygene air muſt have been purer than that which ſhe had breathed before, as it had ſtood by a long time in the air-holder, in which ſome water was purpoſely left to abſorb the fixed air, from which I have reaſon to think that it was not thoroughly freed during its paſſage through the refrigeratory.) At this and the ſubſequent repetitions of the application, the ſtrokes of the artery in the wriſt were ſtronger and fuller than before the inſpiration. On account of pain in the ſide, head-ach, and uneaſineſs at the ſtomach, of which ſhe complained the next day, the application was ſuſpended, and was not again repeated till the 22d of January, when ſhe breathed only a quart of oxygene. In the interval no other medicine was given but Rochelle ſalts, to keep the belly open, and take off the fullneſs and quickneſs of the pulſe. — 23d. A quart more. — 24th. The ſame quantity. Mr. Taylor, the apothecary to the hoſpital, ſuperintended the laſt mentioned applications, as I was prevented from being preſent myſelf. When I ſaw the patient the day after the laſt inhalation, I found her pulſe, appetite, ſpirits, and countenance much improved. An accident having befallen the apparatus, and the ſtock in the air-holder being exhauſted, we were obliged to diſcontinue the application. The girl was diſcharged on the 31ſt of January, much better as to her general health, and particularly with more colour and more animation in her countenance; but in reſpect to the menſtrual evacuation, the ſame as before. When ſhe left the hoſpital, ſhe had directions to come again after five or ſix

 weeks;

weeks; when, if the ſuppreſſion of the menſes ſhould ſtill continue, I intend to repeat the pneumatic application. —— I have likewiſe given oxygene air to another patient afflicted with epilepſy joined with amenorrhæa; but as I have not, in this caſe, repeated the application ſufficiently, I do not yet think myſelf warranted to ſpeak of its effects.

I am, dear Sir, with great regard, your's,

RICHARD PEARSON.

Birmingham, Feb. 2, 1795.

P.S. From what I have ſeen of the effects of oxygene, I think it ſhould at firſt be applied in more diluted doſes than thoſe in which you ſeem to have given it. In my little pamphlet I have ſaid (p. 4) that "at the firſt time of uſing it, it ſhould be mixed with 8 or 10 times its bulk of atmoſpheric;" but I think it will in moſt caſes be prudent to dilute it with as much as 12 or 15 times its quantity of common air.

Extract of a Letter from DR. THORNTON.

A gentleman, Mr. T———d, was recommended to me by Mr. Baker; he had been afflicted with aſthma for the laſt 13 years. Having loſs of appetite, great muſcular weakneſs, cold extremities, and a languid pulſe, I directed him to inhale a ſuper-oxygenated air. After ſix weeks trial of the efficacy of this new means, accompanied with medicines, his aſthma was not diminiſhed, which ſurpriſed me, as I had in this way relieved and cured ſeveral aſthmas this winter and the preceding, but on the contrary it ſeemed ſomewhat increaſed. This gentleman was now ſeized with a violent cold; fearing the recent oxygenation might increaſe the inflammatory ſymptoms, I directed him to

inhale

inhale hydrogen gas, diluted with atmoſpheric air. The heat and ſoreneſs at his breaſt were immediately taken off. He repeated this, and he is himſelf fully perſuaded, from the knowledge he has of his own conſtitution and the laſting effects of a cold with him, that the hydrogene gas prevented, or rather cured this catarrhal attack; upon a more particular inquiry, I found he was in the habit of relieving his aſthmatic fits by going to the play, which ſucceeded if he went into the upper gallery, but not if he ſat in the pit, and that a ſharp eaſterly wind was ſure to bring on a paroxyſm, if he walked in the face of it; and that he was never ſo well as in crowded rooms, and in foggy damp air.

When Mr. T——d inhaled an oxygenated atmoſphere alone, he was accuſtomed, though the oxygene was very conſiderably diluted, to awake early with difficulty of breathing, a long fit of coughing, the breath hot, and the tongue parched. When he began to inhale the hydrogene air, he fell aſleep ſooner than before, ſlept compoſedly, and had none of the above ſymptoms. Since the catarrh was cut ſhort by the hydrogene, I have ventured to give him a little oxygene by day, with hydrogene at night. He is going on well; falls aſleep ſoon after taking the hydrogene, and is quite exempt from the above-mentioned diſagreeable complaints.

I cannot help adding, that I had lately an opportunity of obſerving a fact, which ſeems to favour your idea of muſcular motion, as dependent upon oxygene. An aſthmatic patient after going up ſtairs was always obliged to remain quiet in her chair near ten minutes, before ſhe could enter into converſation. The progreſs of her recovery not being ſo ſpeedy as ſhe could wiſh, ſhe

fancied

fancied the vital air in a ſtate of dilution did her no ſervice.—After inhaling the quantity I judged prudent, I have begged her to go down ſtairs, and walk up as quick as uſual, or rather more ſo, which ſhe obligingly did, and was then able to converſe the moment ſhe entered the room.

Ever your's,

R. I. THORNTON.

The Rev. Mr. F———, at Briſtol Hotwells, much troubled with dyſpnœa, and mucous expectoration, uſed to aſſure me, that after inhaling diluted oxygene air, he could walk up the ſteep hill to Clifton, with much greater eaſe than at other times. He made the experiment innumerable times. This air, however, rendered him no permanent benefit; his diſorder depending upon mal-conformation.

We may admit theſe facts, as they ſeem clearly aſcertained, and ſupported by many analogies. But would not æther or other drugs have done the ſame? And was the effect procured by the *ſpecific* power of oxygene? A good reaſoner ought not to admit ſuch power till there ſhall have been made a number of comparative experiments, of which no man has perhaps conceived the idea. It is, for inſtance, poſſible, for any thing we know to the contrary, that certain ſubſtances introduced into the ſtomach ſhall prevent an animal from drowning ſo ſoon as its unprepared fellow, without communicating oxygene to the ſyſtem, and thus, to a certain degree, rendering reſpiration ſuperfluous. In this caſe it would be doubtful whether oxygene acts

on

on the ſame principle as the bodies, producing an effect ſo far equivalent, or on a principle peculiar to itſelf. When we are acquainted with the reſult of theſe more extenſive reſearches, we ſhall not be in ſo much danger as at preſent of being ſeduced by narrow views into wrong concluſions.

In November, 1794. Mr. James Tobin, of Briſtol, informed me he had heard of inſtances of amauroſis, in which benefit had been derived from inhaling oxygene air. From my own experience I could not give him any encouragement, except as to the probable ſafety of the trial; but as he had loſt the ſight of one eye entirely by this diſeaſe, and had that of the other exceedingly impaired, he determined upon the experiment. He ventured upon the quantities ſpecified in the following note, with which he favoured me from memorandums made at the time. Not the ſmalleſt difference for the better or the worſe was experienced at the time or ſince as to his viſion.

" Mr. James Tobin for fourteen days in December, 1794, took of atmoſpheric mixed with equal parts of oxygene air, from five to ſix of Mr. Watt's ſmaller cylinders daily; having diſcontinued it for a fortnight, he began again taking of the ſame proportions five cylinders for nineteen days:— four minutes are more than ſufficient for the breathing of one cylinder (i. e. ⅓ of a cubic foot) of this air. Mr. J. T. has occaſionally breathed the pure oxygene without any inconvenience, nor could he abſolutely aſcertain any effect from the mixed air, though he ſometimes thought he derived from it the power of reſiſting cold. The proportion of oxygene is ſo great

great in this mixture as to add brilliancy to the flame of a candle after it has paſſed through the lungs."
——*March* 23, 1795.

I have received general information concerning ſeveral other patients to whom oxygene has been adminiſtered. Complete reports will, I hope, be publiſhed in due time. In ſome of thoſe patients ſcrophulous tumours have diſappeared during this treatment. In one a combination, which I had recommended ſeveral months ago in ſuch caſes of cancer as ſhould reſiſt the external application of carbonic acid or other unreſpirable airs, has been employed with great advantage, and will probably effect a complete cure. Carbonic acid air having been applied for three months to a cancerous ulcer of the breaſt without mending its ſtate, it was conceived that the inhalation of oxygene air, together with the continuance of the external application of the c. acid, might produce an effect to which the latter alone was not equal. In leſs than a fortnight after this alteration in the treatment, good pus was diſcharged, healthy granulations appeared, and the ulcer was much diminiſhed. There has ſince been a gradual progreſs toward recovery, and the cancer, I am well informed, "is all but healed."

XVIII.—*Caſes*

XVIII. — *Cases in which different unrespirable airs were administered.*

Letter from DR. FERRIAR.

Manchester, Jan. 23, 1795.

SIR,

It would afford me sincere pleasure if I could furnish you with any decisive proofs of the efficacy of Pneumatic Medicines; but my trials of them have not yet been numerous, and my patients have not been so regular and persevering as I could have wished. I began to use hydrogene about two months ago, with an elderly man, who had every symptom of confirmed phthisis, and whose complaints had been ushered in by hæmoptoe. His pulse was 120, and very quick; on that day when he first breathed the mixture, there was $\frac{1}{4}$ of hydrogene. He remarked that he did not cough during the rest of that day; and the next morning his pulse was only from 60 to 70. By administering a dose of the air morning and evening, and increasing the proportion of hydrogene to $\frac{1}{3}$, he obtained several easy nights, tho' the weather was frosty, and a thick fog prevailed for several days. These favourable appearances are now over; for the air no longer gives him relief, owing, I apprehend, to the period of the disease. When the hydrogene lost its efficacy, I gave him the hydro-carbonate, and afterwards oxygene, without benefit.

The next case in which I used hydrogene was that of a lady who had been harassed with a spasmodic asthma upwards of 11 years. During the last two years and half, she had seldom been free from a paroxysm above four days together. After breathing the mixture

mixture with a third of hydrogene, ſhe complained of a ſenſation of fulneſs in the lungs, and of ſevere coldneſs. I prevailed upon her to uſe the medicine twice a-day for ſome time; and ſhe has certainly been more free from the aſthma than ſhe had been at any time for the laſt three years. In the courſe of two months, ſhe has had only two paroxyſms, and they have been ſhorter than uſual. I have attempted to relieve her during the paroxyſm, by giving oxygene, but without effect.

I made a patient at the Infirmary inſpire a mixture, with the common proportion of oxygene in my preſence, a few days ago. The man has had a ſevere aſthma during ſeveral years, which only quits him in the middle of ſummer. He had been once free from his complaint for a conſiderable time, by taking bark and opium under my direction. After inſpiring the air, he ſaid he felt himſelf perfectly eaſy, and that if he could continue ſo, he ſhould think himſelf well. He has neglected, however, to return as I deſired, for another doſe.

I have found no inconvenience reſult from the exhibition of the airs; on the contrary, the conſumptive patient whom I firſt mentioned, thought his appetite and ſpirits improved by the uſe of the hydrogene.

I hope, in a ſhort time, to acquire more facts on this ſubject; in the mean time I ſhall be very happy if theſe ſlight obſervations can be of any uſe to you.

I am, Sir, &c.

J. FERRIAR.

To Dr. Beddoes.

Letter

Letter from DR. CARMICHAEL.

DEAR SIR,

The Hydro-carbonate, ſo far as my obſervation goes, has never failed to afford very ſenſual relief in Phthiſis Pulmonalis. Conſumption occurs very frequently in this place; but it rarely happens that a phyſician is applied to early in the diſorder, when much advantage may be expected to be derived from the uſe of modified air. The perſons affected with Phthiſis, whoſe caſes are detailed below, were reduced to the brink of the grave, and cannot therefore be conſidered as favorable ſubjects. I have however the ſatisfaction to inform you, that the hydro-carbonate has hitherto reprieved one of them, and that the ſufferings of the two others were uniformly and greatly alleviated. No medicines having been uſed at the ſame time, the effects produced are to be attributed entirely to the virtues of the factitious air.

J. A. applied for my advice Dec. 1, 1794; has very frequent cough, attended with copious expectoration, pain of his ſide, diſpnœa on the ſlighteſt bodily exertion, colliquative ſweats and diarrhœa, very reſtleſs nights, ſtrength much impaired, p. 115. Theſe complaints originated about five months ſince without any evident cauſe, and notwithſtanding many remedies uſed have continued to increaſe. I prepared a mixture of hydrocarbonate and common air, in the proportion of one quart to nineteen, which he inhaled at intervals as directed below in J. T.'s caſe (p. 87.)—2. The vertigo produced was conſiderable, and from which he did not compleatly recover for upwards of an hour. Has had a very comfortable night, cough relieved, and he expectorates

torates with more eaſe, p. 108; breathing leſs difficult. —6. Pain of ſide and dyſpnœa gone, cough not ſo frequent, fœtor of the matter expectorated not ſo offenſive, diarrhœa leſs frequent; perſpiration much leſs profuſe, p. 104; ſleep has been uniformly good ſince he began the uſe of the modified air. Vertigo produced ſtill conſiderable, and after having once gone completely off, continues to return at intervals during the day.—13. All his ſymptoms better except in point of ſtrength, which ſeems gradually to decay. His mother requeſted me to inform her whether or not it was my opinion that her ſon could recover; I replied that I had little expectation of ſo favourable an event, but that his life might be prolonged and rendered more comfortable by the uſe of the modified air. From this time, however, for five days, I ſaw no more of him.—18. He returned to-day, and earneſtly entreated me to ſuffer him to inhale the modified air as formerly. All the ſymptoms were greatly aggravated, the fœtor of his breath was intolerable, and his diarrhœa had returned with increaſed violence, p. 120; he breathed the ſame mixture as at firſt preſcribed for him.—19. Hydro-carbonate occaſioned conſiderable vertigo, has paſſed the night comfortably, and ſeems much refreſhed by his ſleep, cough leſs urgent; p. 108.—24. Cough leſs frequent, dyſpnœa leſs urgent, fœtor of his breath leſs offenſive, ſleeps well, body regular, p. 104. Notwithſtanding the relief of his ſymptoms, his ſtrength is evidently declining.—30. Continues the ſame.—Jan. 12, 1795. Since the laſt report, owing to the ſeverity of the weather, he was prevented from attending. I am this day informed that his diarrhœa returned with great violence and carried him off on the 10th inſtant.

S. C.

S. C. æt. 32, was about nine months ſince, in conſequence of expoſure to cold and wet, ſeized with a cough and pain at his breaſt, which ſymptoms were ſoon after attended with conſiderable expectoration. I firſt ſaw him towards the end of July. His cough was then ſevere and attended with copious expectoration of a whitiſh ropy fluid, he complained of flying pains of his thorax, deſpnœa on any ſlight exerciſe, reſtleſs nights, and ſtrength much impaired, p. 100. He was at that time engaged in buſineſs, but as his ſtrength was but ill-adapted to the attendance required, and his mind ſeemed little at eaſe, I recommended to him to leave ſuch ſcenes for the preſent, and if he conveniently could, to retire for a few months into the country. With this advice he readily complied, and I ſaw no more of him until the middle of October, His mended appearance beſpoke the benefit he had derived, he had had no pain in his breaſt for ſome weeks, and could uſe conſiderable exerciſe without any return of dyſpnœa, his appetite was much better, and he in general ſlept pretty well, his cough and expectoration continued in a leſs degree. But this glimpſe of hope was only of ſhort continuance, he gradually loſt the ground he had acquired, to his former ſymptoms new ones were added, ſo that at the end of November, when I again ſaw him, it was but too evident that he could not much longer ſtruggle with ſo formidable a diſeaſe. — Dec. 4. Cough very ſevere, copious expectoration of a ropy whitiſh phlegm, dyſpnœa urgent on the ſlighteſt exertion, nights very reſtleſs notwithſtanding he is in the habit of taking a grain and half of extract of opium at bed time, profuſe perſpirations, p. 110, body regular, appetite and ſtrength much impaired. I directed him to inhale a mixture containing

containing one quart of hydro-carbonate and nineteen of common-air, once a-day, and desired him to omit the opiate at bed-time.—5. Considerable giddiness produced by the hydro-carbonate, and he complains that to-day he feels himself more languid than usual. Slept better than he has been accustomed to do for some weeks past.—10. Cough much abated, expectorates with more ease, pain of his side gone, dyspnœa on motion less urgent, continues to enjoy very comfortable nights, perspirations much less profuse, p. 90.—15. Continues to find relief from the modified air.—20. For the two last days his cough has been rather worse, and his nights restless, p. 100, body costive. I directed him to take a little rhubarb occasionally.—25. Body regular, cough relieved, and he has slept better; for some time past no perspirations, p. 90.—30. He is evidently more emaciated, his voice has become more feeble, and his step is less firm. Cough variable, expectoration rather more copious.—Jan. 4. 1795. Considerably affected by the severity of the weather, cough increased and attended with a sense of tightness in his breast, and at times with pain under his sternum.—27. I heard nothing of him for some days subsequent to the last report. Finding himself getting worse, he was advised to apply elsewhere, but medicine was of no avail, and I am informed that he sunk under his complaints two days since. — Had it been possible for me to have supplied this patient, and him whose case is before detailed, with modified air at their own houses, during the unusually severe weather, might they have not recovered?

J. T. æt. 40, has for two years past been affected during the winter and spring months with cough and expectoration,

expectoration, and at times with pains in his breast, accompanied with slight dyspnœa. These symptoms in general left him during the summer months, and never at any time arose to such a degree as to prevent him from following his usual occupation. In the beginning of October last, he was seized with pain of his side, cough, dyspnœa, and after some time with copious expectoration. He applied for my advice in the beginning of November. At that time he had an almost incessant cough, attended with copious expectoration, he complained of a sense of tightness across his thorax, and much dyspnœa on the slightest exertion, his pulse was in general from 110 to 120, his nights were restless and attended with profuse perspirations, his body was irregular, his appetite much impaired, his frame much emaciated. I ordered for him at different times emetics, squills, ammoniacum, blisters, &c. but from none of them did he derive more than a very temporate relief. —Nov. 27. He began the use of the hydro-carbonate. I directed him at first to inhale a mixture containing a quart and a half of this species of factitious air, and nineteen of atmospheric air. This quantity he used in about twenty minutes, breathing it for twenty seconds together, and then resting for one, two, or three minutes, according to the degree of vertigo produced.—28. The vertigo produced by yesterday's inhalation was very severe, and returned at intervals during the evening. He has passed a much better night than usual, and says that the dyspnœa and sense of stricture on the thorax are much relieved. The quantity of hydro-carbonate diminished to one quart, diluted as above.—30. Cough much relieved, sense of stricture gone, dyspnœa less troublesome on motion, has had better nights, and his perspirations are less profuse, p. 106, apppetite rather

better,

better.—Dec. 7. Cough evidently better, expectoration considerably diminished, p. 95, body for some days past regular, breathing so much improved that he can with ease walk up stairs to his chamber and undress himself, without return of dyspnœa, which he could not before accomplish without the greatest difficulty, sleeps better than he has done for months past, perspirations entirely left him, appetite mended.—15. Continues to recover in every respect, has at times some return of tightness of his breast, but which is uniformly relieved or completely carried off by the hydro-carbonate. His countenance is evidently altered for the better, and he is of opinion that his strength returns. Notwithstanding that the modified air still continues to produce considerable vertigo, I increased the quantity to two quarts, diluted as before.—27. Cough very much relieved, expectorated matter reduced to one-third of its former quantity, p. from 84 to 90. He has evidently acquired flesh, and he is of opinion that his strength continues to improve.—Jan. 6, 1795. Cough rather more frequent, and attended with some degree of dyspnœa. On account of the severity of the weather, which evidently affects him, I ordered him not to stir from home. At this time he began to breathe the modified air of the strength directed above, twice a-day.—16. Cough relieved, quantity of expectorated matter much the same as reported on the 27th ult. in other respects the same.—Feb. 1. On account of the unusual severity of the weather, no advance has been made since last report. Cough more variable, and at times attended with some degree of dyspnœa, expectorated matter rather increased, he does not however emaciate.—12. Cough much abated, quantity of expectoration reduced to one fifth of its former quantity,

his

his ſtrength is ſo much recruited that it is with difficulty I can reſtrain him from returning to his occupation. In every reſpect he is much better.—March 1. Continues to gain ſtrength, cough leſs frequent, and expectoration ſtill diminiſhing in quantity, appetite good, ſleeps well. As I could not prevail with him to remain longer at home, I adviſed him, before he returned to his uſual occupation, to walk out a little daily.

It is much to be regretted that this patient would not be perſuaded, or could not afford to devote himſelf entirely to the care of his health. His return, however, to his uſual occupation, and conſequent expoſure to the ſeverities of ſuch a ſeaſon, form an æra in his caſe; and Dr. Carmichael has promiſed me a continuation of his hiſtory. I ſhall not fail to communicate the event to the public in the courſe of the preſent year: caſes now in progreſs, beſides thoſe mentioned in this pamplet, will enable me in a few months to add a ſmall Appendix.—This patient recovered perfectly, as may be ſeen in Dr. Carmichael's curious account, publiſhed in the promiſed appendix, viz. *Conſiderations*, Part III. [T. B.]

In preſcribing the uſe of this ſpecies of factitious air, ſuppoſing my patient to be 19 years of age or upwards, I begin by directing 1 quart of hydro-carbonate to be mixed with 19 of atmoſpheric air. In this proportion it may be inhaled for fifteen or twenty ſeconds together, without producing much uneaſineſs of the head or vertigo; it is then prudent to deſiſt until ſuch time as any feeling occaſioned by it goes off, which will in general require from one to five minutes. Vertigo univerſally accompanies the uſe of the hydrocarbonate, even in much ſmaller doſes than thoſe which

I have above directed. At first the patient is sensible of a tightness across his forehead, and a sense as of something creeping round his ears and back part of his head. These symptoms gradually increase, until they are lost in vertigo, or if imprudently too much has been given in a slight degree of apoplexy. I have made use of spirits, water, and volatile effluvia, to restore patients overcome by this species of modified air, but nothing seems to answer the purpose so well as exposing them freely to a current of the atmosphere. I in general make use of incipient vertigo as a test how much of the mixture patients may breathe at a time, and unless it produces more or less of this effect, I do not find that the advantages derived are so conspicuous. The proportion of the hydro-carbonate may be increased as the system becomes habituated to its operation. J. T. at this time takes a gallon of hydro-carbonate diluted with four gallons of atmospheric air, twice a-day, and without producing much disturbance in the system. The other two patients never inhaled the modified air stronger than in the proportion of two to eighteen, nor oftener than once a day.

In preparing the hydro-carbonate, I find it to be of the utmost consequence to suffer water to pass from the water-pipe in the most gradual manner. By doing so the air comes over much slower, but its purity compensates for a little loss of time. If much water is used a considerable quantity of hepatic and aerial acid airs are generated. The latter is of little consequence, as it may be absorbed by quick-lime put into the refrigeratory, but the former being inseparable from the hydro-carbonate, increases dyspnœa when present, and I have suspected it sometimes of occasioning pains in the breast.

The

The hydrocarbonate looſes much of his activity by keeping, it does not produce vertigo in the ſame degree, and I have not obſerved the ſame beneficial effects reſult from its uſe. On recurring to freſh prepared air, it is neceſſary to begin again with a very ſmall doſe.

I am, dear Sir, &c. &c.

JOHN CARMICHAEL.

Birmingham, Feb. 12, 1795.

The collection of letters from Dr. Withering and others being out of print, and not likely to be ever republiſhed, I ſhall extract the following important obſervation. Whatever opinion be formed concerning the nature of the caſe, the patient clearly appears to owe her life to the pneumatic treatment.

Extract from a letter from Dr. EWART, *dated November 14th,* 1793.

The other caſe in which I employed the inhalation of mephitic air, was that of a lady (Mrs. P) aged about 22 years; who nearly two years and a half ago, was ſeized in Ruſſia with ſymptoms of a violent pleuriſy, after incautiouſly eating iced cream when over-heated. Notwithſtanding blood-lettings and other evacuations, the inflammatory ſymptoms ſeem to have run into a rapid ſuppuration; for eight or ten days after the firſt attack, and after a ſevere fit of coughing, almoſt immediate relief followed the ſudden expectoration of a large quantity of what was deemed pure pus, ſlightly intermixed with blood. But though the pain and dyſpnœa now abated, ſtill a frequent cough and a very

copious expectoration of a similar matter to that discharged at first, remained; and soon her fever assumed a hectic form. She was in this situation recommended to come to England, but experienced no benefit either from the sea-voyage or from the use of the Bristol hot waters, which she drank during some months. So much of her case I give from her own report. From Bristol she came to Bath in the beginning of last January, when I first saw her, eighteen months after the commencement of her illness. The state of circumstances then was, very considerable and *progressive* emaciation, an almost constant hectic flush on the countenance, the pulse always quick, with regular and strong exacerbations of fever towards evening, which again abated before morning, and were succeeded by profuse sweats; the cough was very frequent, and the expectoration so profuse as completely to wet many handkerchiefs daily. She began now to inspire mephitic air, pretty nearly in the same manner as Colonel Cathart had formerly done. She not only repeated, however, the inhalations from the machine oftener and continued them longer each time than was done in his case, but even while she was not inspiring through the tube, the machine generally remained on a table near her, emitting the fixed air which was continually extricated from the mixture of calcareous earth and vitriolic acid it contained, so that I seldom entered her apartment without perceiving mephitic fumes in a greater or less degree. The apartment being close and of no great extent, I sometimes thought it prudent to have a window opened for the purpose of clearing it of these fumes. Particular circumstances rendered it necessary that I should inform the lady's relations without reserve, what chance I saw of her recovery; and

and in the beginning of my attendance I did not hesitate to express my despair of doing her any good, or of ever seeing her better. Such however was soon the abatement of all her symptoms under the above treatment; so entirely for some weeks did the hectic fever disappear; and so evidently did she gain during the same period both flesh and strength, that not only her relations acquired new and sanguine hopes of her recovery, but I began seriously to flatter myself with a disappointment of my predictions, although I durst not venture to avow it. The first check given to this amendment, which proceeded for four or five weeks, was occasioned by an over exertion of her lately recovered strength, during a fatiguing walk, the latter part of which was up a pretty steep ascent. A return of pain in the breast and dyspnœa, a tinge of blood in the expectoration, together with an accelerated pulse, made me have recourse to blood-letting, blisters applied to the chest, &c. which greatly relieved these symptoms, but at the same time reduced the general strength. The inhalation of mephitic air was interrupted during the period of this inflammatory attack, from an uncertainty how it might act, rather than from any observation of its disagreeing; but it was repeated as before, after the symptoms of inflammation had abated, and again seemed to produce the same beneficial effects. A second relapse however occurred some weeks afterwards from a slight indiscretion, the throwing off part of her accustomed garments. This was removed much in the same way as the former one, and the mephitic air was again resorted to with similar success. After each of these inflammatory attacks, and after one or two others which happened subsequently, there remained for some time a considerable

increase

increaſe of cough and expectoration, and a permanent hectic, which however gradually abated under the uſe of the mephitic air. But theſe repeated relapſes from ſlight cauſes, notwithſtanding the conſtitution rallied aſtoniſhingly afterwards, and ſoon ſeemed to regain all it had loſt, renewed my fears that the diſeaſe would ſoon run the uſual and rapid courſe of confirmed phthiſis. The patient left Bath in the month of May laſt, to take advantage of the ſummer ſeaſon for trying another voyage by ſea, ſtill bent on continuing the inhalation of mephitic air. I deſpaired of hearing much longer any ſavourable accounts of her; but have been repeatedly and agreeably diſappointed, in learning that her health has ſince gained inſtead of loſing ſtrength. By a letter received within theſe few days from Peterſburgh, where ſhe has paſſed the ſummer, it is reported to me "that ſhe is wonderfully recovered by the Balſam of Mecca, which ſhe got from the Turkiſh Ambaſſador." Whether ſhe has all along continued the mephitic air, I cannot undertake to aſſert, but I believe in the affirmative, from her intentions at the time of leaving this country. To whatever cauſe her preſervation is owing, it is the firſt caſe of ſo fully formed, and ſo far advanced a phthiſis that I have met with, in which the progreſs to diſſolution has been ſo long reſtrained, or ſo ſucceſsfully repelled.

I remain, dear Sir, &c.

JOHN EWART.

——Accounts from Peterſburgh of a late date ſtate the amendment of this lady to be more conſiderable than I ventured in my laſt letter to repreſent it. It was her intention to paſs the winter in the South of Ruſſia,

but

but ſhe now thinks herſelf ſo well as to be able to remain with impunity at Peterſburgh. The expreſſions of her father in a letter to her ſiſter are, "She has re-"covered progreſſively ever ſince ſhe returned here, "regains fleſh and ſtrength, is free from fever, and "ſuffers very little from her cough, but continues to "ſpit immoderately, though with eaſe." No mention is made in this letter whether ſhe perſiſts in reſpiring fixable air.

Your's, &c.

Bath, Dec. 15, 1793. J. E.

Bath, March 25, 1795.

MY DEAR SIR,

In the beginning of the winter Mrs. P. was found to be pregnant, and has been delivered of a healthy child. Lady H. from whom I had an account within the laſt fortnight, mentions no particular ſymptoms, but only ſays her ſiſter is vaſtly well. She has not breathed any factitious air ſince her return to Ruſſia; ſo that all which can be inferred from her caſe, applicable to your ſubject, is the evident amelioration of ſymptoms which firſt began to take place here under the caſe of the carbonic acid air. I have ſince adminiſtered the ſame air in a conſiderable number of caſes of phthiſis. I can ſay with confidence that in moſt of them it relieved the cough; but in none of them, where the diſeaſe was fully formed, could it be ſaid to produce beneficial effects in any degree equal to thoſe obſerved in Mrs. P.'s caſe. In two caſes of apparently incipient phthiſis, the ſymptoms entirely

diſappeared

disappeared under its use ; but the difficulty of distinguishing certain states of simple catarrh, from the first stage of genuine phthisis, leaves it with me still a matter of doubt, whether these two cases were strictly of the latter description or not.

One remark on Mrs. P's. case is likewise obvious, that although her disease had proceeded to a very formidable length, with every symptom which characterizes the last stage of phthisis, yet as it originated in a pleurisy, brought on by a sudden cause, and without evidence of any particular predisposition to phthisis, it may have been a simple imposthume in the lungs, unattended by tubercules.

Yours, &c. &c.

J. EWART.

Dr. Pearson, in a letter from Birmingham, dated January 15, 1796, informs me that he has continued to direct the æther-vapour with much advantage.— "My facts," says he, "in favour of æther-vapour, in "phthisical cases, are multiplying so fast, that in "about another half year, or by next winter at farthest, "I expect to have a number of cases worth communi-"cating to the medical world." He has varied his method, by making additions to the æther, as he will no doubt relate at length, if happily his expectation should be fulfilled.

Concerning Dr. Thornton's comments, he proceeds, on my observations on yeast *, I have to remark that I approve of the freedom with which he writes. But I am

* See Considerations, Part III. p. 101.

I am by no means convinced that the violent operation which I have ſeen from its uſe, was merely the effect of flatulency. In every draught of bottled beer or porter, we probably take as much fixed air as is contained in the aſſigned doſes of yeaſt; and, yet, windy as they are, theſe liquors do not (unleſs taken immoderately) excite vomiting or purging. Perhaps Dr. Thornton will account for this from the alkohol or brandy that is in them; but he cannot ſay the ſame of pure water ſaturated with fixed air, which, in proper doſes, neither diſorders the ſtomach nor bowels. The arguments drawn from the effects of yeaſt applied externally, and the analogical reference to the carrot-poultice, have very little weight: for, although I readily aſcribe with him their beneficial effects, when uſed in that manner, to the fixed air which they give out; yet there is a wide difference between the ſtate of the ſkin and the ſtate of the ſtomach—between the former when affected with foul and ſphacelating ulcers, and latter as it is in typhus, without ſuch ulceration, whatever elſe may be its morbid condition. The fermenting pulp of the carrot would be but a clumſy vehicle for conveying fixed air to the ſtomach in the goal or other fever; it would oppreſs by its bulk and indigeſtibility. In like manner, yeaſt is unfit, as an internal medicine, in many caſes, where fixed air, applied through a lighter and ſimpler medium, would be ſerviceable, not only on account of the bitter oil of the hop, with which it is impregnated, but alſo on account of the inſolubility or indigeſtibility of the feculent or glutinous matter, which conſtitutes the chief part of its bulk. This part is barely miſcible with, but not ſoluble in water, whether cold or hot. It is

in like manner inſoluble in ardent ſpirit. It ſerves to give form and body to the remedy when uſed externally: but it is oppreſſive, irritating, and in every way offending, when applied internally. By means of a little gin, or any other ſpirituous liquor, the ſtomach may, in ſome caſes, be made to bear it. Many other offending ſubſtances are, by the ſame means, rendered tolerable to it; but by ſuch an addition we only convert the yeaſt and water (with which it is diluted) into a bad kind of fermenting liquor, the end of which will be much better anſwered by a draught of bottled beer, porter, perry, &c. On the whole, I have no doubt that yeaſt will ſtand its ground as an external application; but I fear it will daily loſe its reputation as a remedy internally. I cannot account for the benefit which Dr. Thornton has uniformly experienced from the exhibition of it in caſes of fever, otherwiſe than by ſuppoſing he has uſed the frothy part only, ſeparated from the denſer liquid part, which ſubſides by ſtanding. If ſo, the Doctor ſhould make this circumſtance known. R. P.

Dr. Pearſon has lately given from Dr. Bergius an intereſting experiment on the celebrated remedy of *cow's-breath* in conſumption. A Swediſh lady, who had been ſubject to ſpitting of blood, was affected with cough, great expectoration and night ſweats. She was exceedingly emaciated; difficulty of breathing rendered it neceſſary to bolſter her up: ſhe had conſtant diarrhœa and ſwelling of the feet. In this laſt ſtage of conſumption, when the phyſicians had relinquiſhed all hope, a large hall was provided with ſtalls for four cows, and with a ſtage on a level with the heads of the cattle, upon which the patient's bed and chairs were placed.

placed. She took poſſeſſion of this ſtation in September: in a month ſome amendment had taken place; and by Chriſtmas all her ſymptoms were ſurpriſingly mitigated. Her fever was abated ſo much that her pulſe had become natural. In ſummer ſhe was able to quit her habitation; ſhe gained fleſh; the catamenia returned; and ſhe had to complain only of a ſlight cough and quickneſs of breathing when ſhe walked. The enſuing winter ſhe would not ſubmit to paſs her days in the hall with her cows. In the ſpring ſhe caught cold, and ſuffered much from inflammation of the lungs. The phthiſical ſymptoms returned in autumn; but ſhe now refuſed even to paſs her nights near the cows; ſhe died at the end of winter. The progreſs of this caſe during the firſt winter differs ſo totally from the conſtant courſe of conſumption, eſpecially when the patient is far reduced, that we can ſcarce heſitate to aſcribe efficacy to the plan purſued, Dr. Pearſon thinks the patient's eſcape from imminent death may be imputed to the lowered atmoſphere and the carbonic acid produced by the reſpiration of the cattle. I do not ſuppoſe much will be attributed to the balſam of their breath.

If nothing was owing to the fumes of volatile alkali, with which the atmoſphere of the hall muſt have been loaded, we may at leaſt conclude that no injury is likely to ariſe from the ſpirit of hartſhorn in the apparatus repreſented in Pl. IV.

In the pamphlet whence this obſervation is taken, the beneficial effect of the atmoſphere of the Weſt India ſugar-houſes in conſumptive caſes is noticed. Carbonic acid abounds in theſe places. I have recei-

ved

ved intelligence of the complete recovery of a confumptive patient who conftantly breathed the air of an American tar-houfe, which I fuppofe may be of much the fame quality as that of the fugar-houfes.

The following fact I fhall not attempt to force into the fervice of my fpeculations. I leave it, as the relater has judicioufly done, to be determined by others whether the kind of atmofphere the patient breathed for fo long a continuance had any fhare in the ultimate effect. That much was owing to another obvious caufe I do not pretend to doubt, and it feems worth preferving as an inftance of the good effect of long-continued naufea and repeated vomiting. Moreover, the narrative may fuggeft the trial of complicated powers where the fingle fail. Turn and twift our means how we can, we may efteem ourfelves happy when we fucceed at laft.

Letter from MR. CHISHOLM *to* DR. EWART.

Bath, February 16, 1795.

DEAR DOCTOR,

The cafe which you defired I would fend you an account of, was as follows: — A negro man, a fervant of mine, aged 28 years, of a ftrong mufcular make, a bricklayer, in December 1787, after fpending fome days in hard drinking, and dancing in the open air, was feized with a violent pleurify, attended with ftrong fever, and all the ufual fymptoms; he was feveral times let blood and bliftered; he alfo took a good many dofes of James's fever powder; by which the fymptoms of general, as well as topical inflammation, were much abated, and it was expected he would foon re-

cover,

cover. He however continued to complain, and in a few days it became evident, that matter was forming in the right lobe of the lungs; some weeks thereafter he suddenly brought up a considerable quantity of ill-degested matter, mixed with much blood. I immediately on this had him removed to my own house, where, during two months, both food and medicine were administered to him with the greatest attention. During all that time, however, he continued to be afflicted with a most incessant cough, expectorating considerable quantities of very ill digested matter, always much tinged with blood, a great degree of hectic fever, and at last profuse colliquative sweats, with great loss of strength. I was perfectly satisfied he must soon die, of which he himself was so much convinced, that he requested I would send him home, as his wish was to die in his own house. I then proposed he should try the effects of a short voyage at sea, to which he consented; he was accordingly sent in a chaise to our nearest shipping place, distant about 20 miles, with directions to have him put on board of one of the small vessels employed in the coasting trade of Jamaica. He was accordingly put on board of a single decked vessel, about sixty tons burden, the only one at that time about to sail from our port, and I heard no more of him for six weeks; at the end of that time I received a letter from the person who had the care of the wharf, informing me he was landed there in a dying condition, and desiring I would send a chaise for him; which I accordingly did, with directions to make very short stages. At the end of four days he was brought to me, and to my astonishment appeared in good spirits, and seemed convinced he should recover. On examining I found his pulse good, the hectic fever having entirely left

him,

him, and although he had ſtill a ſhort teazing cough at times, there was nothing expectorated. From that time he took no medicine whatever, but was plentifully ſupplied with nouriſhment, conſiſting principally of panada, rice, and milk: in three months was perfectly reſtored to health and ſtrength, and went to work as uſual; he is ſtill alive, and in good health, and has never had any return of his pulmonary complaints.

The account he gave of his voyage was this: —— Immediately on the veſſel's ſailing, he was ſeized with a violent vomitting, occaſioned by ſea-ſickneſs, which continued with ſhort intervals, during the whole time he was on board; that being unable either to ſtand or ſit up much, he ſpent the greateſt part of the time, under the deck of the veſſel, lying on the top of the cargo, where the air is neceſſarily very bad, as theſe veſſels are generally loaded either with hogſheads of raw ſugar and puncheons of rum, or barrels of ſalted beef and pork, and I believe are very ſeldom ventilated. The only nouriſhment he took was ſhip biſcuit, pounded and mixed with water; he was, in conſequence, when firſt landed, reduced to ſo great a ſtate of debility and langour, he imagined he was dying, but after a night's reſt, and having taken a good deal of wholeſome nouriſhment, his ſpirits were reſtored, and he found his original complaints had in a great meaſure left him.

My own opinion at the time was, that his cure had been effected by the frequent vomitting, not having ever heard any thing of the beneficial effects of ſowered air. What ſhare that might have in the cure, you are a better

a better judge; the caſe was ſimply as above ſtated, on the truth of which you may rely, every part having paſſed under my own daily obſervation, excepting during the time he was on board the veſſel; and of the truth of his account of that, I have not the ſmalleſt reaſon to doubt.

I am, your's, &c. &c.

To Dr. Ewart. JAMES CHISOLM.

Extract of a letter from Dr. CARMICHAEL.

Birmingham, March, 1795.

I. B. æt. 45, was attacked about four months ſince with difficulty of breathing, attended at times with pain under the ſternum, and commonly with a ſenſe of tightneſs of the thorax, frequent cough, with copious expectoration of a tough whitiſh fluid, p. 96, body regular, appetite variable. He has ſeldom paſſed four and twenty hours without a material aggravation of all his ſymptoms. Was firſt attacked with this diſorder ſix years ago, and has regularly ſuffered very ſeverely from it every winter ſince that period; it has always left him about the beginning of May, and he has kept free from complaint during the ſummer and autumn months. He has tried many remedies, but never with more than very tranſitory relief.

February 14, 1795, I directed him to inhale daily a mixture of hydrocarbonate and atmoſpheric air, in the proportion of 1 to 19.—15. No ſenſible effects from the uſe of the hydrocarbonate; the ſtrength of the mixture was therefore increaſed in the proportion of 2 to 18.—16. No vertigo, nor any other ſenſible effect pro-

duced by the uſe of the modified air. The proportion ſtill farther increaſed to 4 to 18. — 17. Conſiderable vertigo produced by yeſterday's doſe, which returned at intervals, attended by head-ache during the day. Breathing much relieved, even during the act of inhaling the modified air, and has ſince continued tolerably eaſy. Slept better laſt night than he has been accuſtomed to do for ſome months. — 22. Hydrocarbonate continues to produce conſiderable giddineſs, breathing, except ſome ſhort intervals of ſlight return, continues much eaſier. Cough leſs frequent, expectoration much diminiſhed. Continues to enjoy comfortable ſleep. — 27th. Had a conſiderable return of difficulty of breathing on the afternoon of the 25th, which, however, abated ſo much before his uſual bed-time, as not to prevent him from paſſing the night comfortably. Cough infrequent, and rarely attended with expectoration. Has for ſome time paſt had no pain under his ſternum, and rarely any ſenſe of tightneſs of his thorax. — March 4. He is in every reſpect ſo much better, that he intends to return to his uſual occupation (making moulds in a caſt-iron foundry) on the 9th inſtant. Modified air continues to produce vertigo.—March 9. He continued without any return of his complaint, and returned to his employment as he intended; but after working for a few hours only, he was obliged to deſiſt, by a return of the ſenſe of tightneſs on his thorax, and conſiderable difficulty of breathing.—Breathing increaſed in difficulty towards evening, and ſtill continues, attended by frequent dry cough. — 13. Continues to breathe with conſiderable difficulty, p. 100; ſleepleſs nights; cough more frequent; but now attended with conſiderable expectoration. — 17th. Difficulty of breathing continued until yeſterday;

yefterday; has paffed a better night than ufual; and this morning finds himfelf much better. —20. Breathing continues eafier; cough much lefs frequent; and quantity of expectoration diminifhed. Has flept for fome nights paft comfortably, p. 86. Modified air continues to produce confiderable vertigo. —29. Continues uniformly to recover; his cough is very trifling, and he expectorates better; his ftrength is fo much improved, that he can ufe confiderable exercife without inconvenience. Sleeps uniformly well.—He returns to work to-morrow, but for the prefent is to work within doors. He is of opinion that he is in every refpect equal to the undertaking.

I remain, Dear Sir, Your's, &c. &c.

J. CARMICHAEL.

XIX. Mr. WATT's *hints on the operation of different airs.*

Heathfield, June 17, 1794.

DEAR SIR,

Having never made the art of medicine my particular ftudy, I fhould not have troubled you with my crude ideas upon the ufe of pneumatic medicines, if your appr bation of what I mentioned to you, joined to my earneft defire to aid your endeavors, with the hope that poffibly fome idea might be ftarted, which may fave other parents from the forrow that has unfortunately fallen to my lot, had not urged me to ftep over the bounds of my profeffion.

It appears to me, that if it be allowed that poifons can be carried into the fyftem of the lungs, remedies

may be thrown in by the ſame channel. Remedies for ſome fatal or dangerous diſorders may, poſſibly at leaſt, be found in the claſs of airs, which admit of many *known* modifications, and doubtleſs many more ſtill to be diſcovered : — which of theſe may prove beneficial in conſumption, and other analagous diſorders of the lungs, remains to be aſcertained by experiment. You have ſhewn that oxygene air is hurtful in many caſes of theſe diſorders, though beneficial in ſome caſes of aſthma; its oppoſites inflammable, azotic, and fixed air, ſeem then to be thoſe which are moſt likely to be uſeful in phthiſis: But there are alſo ſubſtances which ſome eminent phyſicians have thought might be uſefully employed even in the ſtate of powder, ſuch as Peruvian bark, the calces of lead and zinc, with other aſtringents.

To the uſe of powders, however finely *mechanically* divided, I think there are ſome objections ; particularly I doubt whether they could enter the minute veſicles of the lungs ; but if ſuch ſubſtances can be *chemically* divided and obtained in the ſtate of ſolution in air of ſome congenial ſpecies, they might have their full effect.

It is well known, that inflammable air, when produced by the common proceſs from iron and vitriolic acid, always carries with it, even through water, a large quantity of iron ; ſome of which it afterwards depoſits, but very probably ſome part ſtill remains ſuſpended. If iron ſhould be then eſteemed a proper medicine for diſorders of the lungs, we are thus furniſhed with the means of obtaining in a ſufficiently divided ſtate ; and to free it from any adherent acid, it may be paſſed through a cauſtic alkali.

If

If the calx of zinc is thought preferable, it is suspended in inflammable air in great quantities, by applying water or steam to red hot zinc in close vessels, and probably also by the common process of making inflammable air from zinc by vitriolic acid. The calces of zinc are very efficacious in healing external sores; and are very likely to be so in internal ones, provided they can be applied, as I think they may, by the means indicated.

Charcoal has lately been found extremely efficacious in correcting putridity, and in disposing ulcers to heal. It seems to me, that no substance is dissolved in inflammable air in such quantities as charcoal, nor more intimately united. If water is applied to red hot charcoal in close vessels, the heavy inflammable air is produced in large quantities; and this air has been found to contain inflammable air, properly so called, fixed air, separable by water or by alkalies, and some other substance, which, when the inflammable air is deflagrated with oxygene air, produces fixed air. This substance I consider as charcoal in a state of solution; for were it fixed air completely formed, it would be separated by the means mentioned. Whether charcoal in this state could be decomposed by any excess of oxygene in the blood of consumptive patients, I cannot say; but it seems likely that it would; and at any rate it would act as charcoal powder does, and therefore highly merits trial.—[Since this was written, these conjectures have been verified; no species of air having been found so effectual in phthisical cases as the heavy inflammable air.]

As fixed air is a saturated solution of charcoal in oxygene air, it is not probable that the lungs can decompose it; we should therefore only look to its

 effects

effects as an antiseptic. As the lungs, when doing their duty, should separate, and throw out fixed air, it is not probable they will absorb it, though it may have some effect merely by excluding the oxygene of the common air.—[It seems now certain that the lungs can absorb fixed air in toto, and that it changes the state of the blood.]—I think, however, it will be found to have most beneficial effects in cases of a putrescent tendency; or if you do not like this theoretical phrase, where the breath and expectorated matter are fœtid. The species I would recommend is that from fermentation, and the means, keeping a vessel of fermenting wort close by the patient, which will in general be found grateful to him.* Fixed air, from vitriolic acid and calcareous earths, may be occasionally much contaminated by other acids. The oil of vitriol of commerce is generally impure, containing sulphureous acid, with the nitrous and marine; it should be rectified for the purpose of medicine.

If it be certain that butchers are exempt from phthisis, putrid animal effluvia may be useful; and if the matter which constitutes the smell be not the useful part, it may be corrected by powder of charcoal, which does not otherwise hinder the progress of putrefaction. The smell seems to be owing to ammoniacal hepatic air.

The mixture of azotic and fixed air to be obtained from burning charcoal (first freed from bitumen by heat) might be tried, but I should hope more from the heavy inflammable air of charcoal.

The

* I know that Mr. W. speaks here from attentive observation.—T. B.

The oxygene air may alſo be impregnated with various ſubſtances. When it is made by paſſing the ſteams of ſp. nitri through a red hot tobacco-pipe, it is highly charged with a white powder, ſome part of which it lays down on the contact of water: when produced in glaſs veſſels, I have never ſeen it contain any ſuch white matter. An eminent phyſician of your acquaintance, previous to my mentioning to him the ideas I now ſend you, obſerved to me, that the oxygene air from heated manganeſe, had a peculiar taſte and ſmell; and that unleſs ſome other facts led to aſcertain the ſubject, he ſhould be at a loſs to determine whether ſome of the cures you mention *might* not be attributed as much to the manganeſe as to the oxygene. He alſo, *a priori*, had entertained ideas of the good effects of ſubſtances diſſolved in airs.

It would ſeem that the more pure the oxygene air can be obtained, ſo much the fitter it is for medicine, but the facts here mentioned may ſerve as cautions, as to the ſubſtances from which it ſhould be obtained.

In regard to the manner of breathing theſe medicinal airs, I think it will be done beſt from bags of ſome very flexible and light ſubſtances, ſuch as very thin leather waxed, or oiled ſilk. If a ſmall tube be inſerted into the mouth of the bag, the air may be preſſed out oppoſite the patient's mouth, in caſes when they are too weak to make extraordinary exertions of the lungs, or rooms may be filled with the proper mixture of airs.

It would be deſirable that a liſt were made out of all ſubſtances, which are known to be ſoluble in air of any kind, or are of themſelves reducible to vapour or ſteam,

ſteam, that experiments may be made upon their ſanative effects in caſes of diſeaſed lungs. The liſt will prove more numerous than may appear at firſt glance.

Having now explained my general ideas, I ſubmit them to your correction.

And remain, &c.

J. W.

July 14, 1794.

DEAR SIR,

I ſend you with this, drawings of my apparatus for producing and receiving the various airs which may be ſuppoſed to be uſeful in Medicine, with a deſcription or explanation of the apparatus, which if you think it worthy publication, I hope may at leaſt prompt ſome younger and more active man to conceive a better.

In conſequence of your deſire, Boulton and Watt have agreed to manufacture theſe machines for the public. We have no deſire to be the manufacturers, except to ſupply thoſe who may not have the ſame opportunities as ourſelves of procuring them; the price ſhall therefore be as moderate as we can make it; and thoſe who chooſe to have them made by others, ſee what is to be done,—Wiſhing you to be ſucceſsful in this undertaking, which promiſes to be of ſo much utility to mankind.

I remain, &c,

J. W.

To Dr. Beddoes.

Sept. 2, 1794.

DEAR SIR,

You desire me to send you a more particular account of my observations on the medical airs than was contained in my former correspondence on that subject. In my letter of June 17th, I mentioned that it seemed to me that the heavy inflammable air, or carbonated hydrogene, being principally a solution of charcoal in inflammable air, was more likely than any other to correct any disease arising from super-oxygenation of the blood. I could not, however, foresee that its effects would be so powerful in some respects as they have proved. In the beginning of July, I made some of this air by the application of water to red hot charcoal in a close vessel. Its smell was somewhat hepatick, from the new cast iron vessel it was made in, and was also contaminated, by a bad linseed oil varnish in the refrigeratory, its taste was that of fixed air, though more feeble. I inhaled a little of it cautiously, but had scarce withdrawn the pipe from my mouth before I became so giddy, that I could not stand without a support. I had also considerable nausea. A healthy young man, who stood about 6 feet from the hydraulic bellows when I discharged about a cubic foot of this air, was effected in the same manner, as it passed by him towards an open door. Another young person, merely from smelling to it as it issued from the bellows, fell upon the floor insensible, and wondered where he was when he awaked. None of us experienced any disagreeable effects in consequence of the vertigo, &c. only in going to bed six hours afterwards, I felt some small remains of the vertigo. Several other persons have inhaled it since; and all were affected in the same manner. I have no doubt, from

what

what I have obſerved, that if inhaled in a pure ſtate, this air would ſpeedily bring on fainting and death; when given as medicine, it ought therefore to be much diluted with common air, I ſhould think with 12 times its bulk. Its effects upon diſeaſed lungs you are better qualified to ſpeak to, and I truſt you will give the neceſſary cautions for the uſe of ſo active a medicine, in a more diſtinct manner than I am qualified to do.

About the ſame time, I made ſome inflammable air by means of zinc; it contained a very conſiderable quantity of the flowers of that metal in a ſtate of ſuſpenſion, which had the appearance of grey ſmoke, as it was diſcharged from the bellows. I breathed this air 3 or 4 times without being ſenſible of any immediate effect; nor could I have diſtinguiſhed it in that manner from common air, though when I blew it out of my lungs againſt a lighted paper match, it took fire. Next morning I ſpit up ſome mucus very ſolid, and at moſt as elaſtick as caoutchouc, and the ſame in a ſmaller degree the ſecond morning; this I attributed to the calx of zinc, which I apprehend it contains in a ſtate of ſolution, as well as of ſuſpenſion.

Of fixed air, I have little to ſay. I have occaſionally breathed it in larger quantities than were agreeable, and always experienced flying ſtitches in the muſcles of my breaſt in conſequence, but they ſoon left me without any medicinal help.

Conſidering that no ſpecies of artificial air is obtained except water is obviouſly preſent, or that there is reaſon to ſuſpect it may be contained as an element, or part of one of the ſubſtances concerned, and that Dr. Prieſtley obtained fixed air from aerated barytes, by paſſing ſteam over it when in a red hot ſtate, though

it would yield none by a mere dry heat, I concluded, that if water or ſteam were applied to calcareous earths when red hot, they would readily part with their fixed air. I put 1½lb. of chalk broken into ſmall pieces into the pot of my apparatus, and, when red hot, admitted ſmall quantities of water. I obtained about 4 cubic feet of fixed air, extremely pungent to the ſmell, and greedily abſorbed by water. The laſt portion was fixed with ſome inflammable air from the iron pot, and the chalk was found to be nearly cauſtic, but had no way changed its form.

This air was free from any ſmell ſimilar to that of aquafortis, which that produced by means of vitriolic acid generally has, and perhaps was more pure.

In purſuance of the ſame idea, I concluded that nitre might yield its dephlogiſticated air leſs reluctantly, if water were added when it was red hot. I put 4 ounces of nitre into an iron pot, and, by mere heat, obtained about 400 cubic inches of air, which being waſhed in its paſſage through the ſpiral refrigeratory, did not taſte of ſpirit of nitre, though it ſmelled ſlightly of it. Fearing that on the addition of water ſome inflammable air might be produced, and there might be an exploſion, I removed the refrigeratory and bellows, and then admitted ſome water. Air immediately iſſued in quantities from the conducting pipe of the pot; and this air was found, on the application of a match, to be dephlogiſticated; but ſome ſpirit of nitre iſſued at the ſame time, and probably ſome azotic air. The pot was conſiderably corroded by the nitre, which had found an iſſue at ſome defective places, that has hitherto prevented a more complete experiment from

being

being made. It would ſeem, from theſe appearances, that my reaſoning was right, and that nitre may in this way be made to yield all its air in a moderate heat. It ſtill, however, remains a deſideratum to find veſſels which can retain in it a red heat for a ſufficient time.

I put 1½ pound of the Mendip mangan eſe you were ſo kind as to ſend me, into the iron pot, and, by dry heat, obtained from it about 1½ cubic foot of air; the firſt and laſt portions ſeemed, by the taſte, and by its extinguiſhing flame, to be fixed air, about half a cubic foot was dephlogiſticated. When it had ceaſed to give air by the heat, I added water, and obtained a conſiderable quantity of fixed air, ſimilar to that from chalk, but in which a grey powder was ſuſpended in conſiderable quantities, which gave the appearance of ſmoke, as it is iſſued from the bellows. A perſon who breathed a little of this air undiluted, experinced a ſlight vertigo and nauſea. May not this proceed from the powder ſuſpended in it?

The purity of the dephlogiſticated air, which you obtained by means of vitriolic acid from the Exeter manganeſe, may not be wholly owing to its ſuperior purity, but to your mode of diſengaging it; for I apprehend concentrated vitriolic acid will diſengage very little fixed air, even from marble, as it ſoon covers it with a coat of gypſum, which protects it from any further action of the acid. If, therefore, this air can be freed ſufficiently from any taint of the acid, the method you have followed ſeems by much the beſt mode of obtaining it, and perhaps the cheapeſt.

In reſpect of pure azotic air, I have tried no proceſſes, but the method I mentioned to you in June laſt,

last, of obtaining a mixture of azotic and fixed air from burning charcoal succeeded perfectly.

I made a chaffing dish about 6 inches diameter, and nine inches deep, into one side of which, near its middle, there was inserted a pipe one inch diameter; to this pipe was joined another about 3 feet long, passing through a trough filled with water, and connected with the hydraulic bellows, the latter being slowly elevated, were filled with the air which had passed through the burning charcoal in the chaffing dish, and this air, upon being poured out of a cup over a lighted candle, extinguished it immediately. Large inhalations were made of it by some of my assistants, without injury to themselves; but, upon me, it produced effects similar to those of fixed air. Its uses in medicine I cannot pretend to predict; but if azotic air is found useful, this may be given in any case, wherein fixed air will be hurtful.

I remain, &c. J. W.

To Dr. Beddoes.

I have just made an air, which, as it has great powers, may, for ought I know, have great virtues; my experience extends only to its bad qualities—*Pyro-sarcate.* I put 2 oz. of lean beef in the fire tube and obtained, by mere heat, 250 c. i. of air, highly fœtid, like an extinguished tobacco pipe; inflammable, with a very blue flame; little diminished by lime and water. —*Pyr-hydro-sarcate,* on adding water to the red hot charcoal of this beef, I obtained 600 c. i. of air, with a fœtor not so bad as the other; burning with an orange-coloured flame; losing not quite $\frac{1}{13}$ in lime water,

ter. The ſmell of the firſt made me ſick, though I did not inſpire any purpoſely, and not above one third of the quantity mentioned was let looſe in my laboratory, and 3 doors and a chimney were open; we were, however obliged to leave the place for ſome time. The P. H. ſarcate ſeemed to poſſeſs the ſame property, but was more cautiouſly treated. G. was giddy all the afternoon. *Pyro-Comate.* Next day, 2 oz. of woollen rags were put into the tube; they gave, by mere heat, 800 c. i. of air; fœtid, though not ſo offenſive as the other; burning with a deep blue flame; not tried with lime and water. — *Pyr-hydro-comate*, by addition of water to the red hot charcoal, gave above $1\frac{1}{2}$ cubic foot of air fœtid, but more like vol. alkali in ſmell—burning with a yellow flame; loſing 1-5th by waſhing with lime and water; part was undoubtedly alkaline air and abſorbed by the water; the water in the refrigeratory was ſtrongly impregnated with fœtid vol. alkali. Though none of either of the airs was inſpired, that could be avoided, I had a ſlight, though uncommon, nauſea, attended with ſome elevation of ſpirits, all that evening, but no heat or thirſt. In ſhort, it was very like the effect of the fumes of tobacco on an unexperienced perſon: In bed I was reſtleſs, though without pain or particular uneaſineſs, I could not ſleep. Next day the nauſea, and ſome giddineſs, continued, or rather increaſed, and a head-ache came on.—The uſes of this air, if it has any, I leave you to find out. I think I ſhall have no more to do with it, or with animal ſubſtances: One may diſcover, by accident, the air which cauſes typhus, or ſome worſe diſorder, and ſuffer for it.

JAMES WATT.

October 7, 1794.

XX. *Facts*

XX. *Facts and conjectures respecting the medicinal use of certain solid and liquid substances.*

Extracts of letters from DR. GARNET.

SIR,

Were we possessed of methods of increasing or diminishing the quantity of oxygene in the system, we should have advanced a great way towards the cure of several formidable diseases. The method of doing this by inspiration is ingeniously conceived, and may, where recourse can be had to it, answer the purposes, but perhaps cannot be generally used.—In considering this subject in the course of the last year, the following question occurred to me: *when oxygene exists in the system in too great a quantity, may not its quantity be easily and successfully diminished by* liver of sulphur *exhibited by the mouth?* When this substance is moistened with water, the water is decomposed; the oxygene uniting with the sulphur, and forming sulphuric acid, while its hydrogene is disengaged in large quantity, which dissolving a portion of the sulphur, forms sulphurated hydrogene gas, which will be readily dissolved by the chyle and conveyed into the blood. It is well known that hydrogene, at a much lower temperature than that of the human body, has a strong attraction for oxygene, with which it unites and forms water; and I have scarcely a doubt that this will take place when the sulphurated hydrogene is taken into the blood; and from some experiments which I have made, I even suspect that the quantity of oxygene in the blood might be so far diminished by means of liver of sulphur, that a real scurvy would be produced. If

I am

I am right, will not this prove one of the moſt effectual remedies in florid conſumption, as well as ſome other diſeaſes which depend upon too great a quantity of oxygene in the blood? That the kali ſulphuratum is a powerful medicine, I have been fully convinced in caſes where I have given it to ſtop or leſſen a ſalivation which has been brought on by mercury. In theſe caſes I have ſeveral times tried it, and have never ſeen it fail; and in 24, or at moſt 48 hours after the firſt exhibition of this remedy, the ſalivation is much abated. I ſuppoſe that the mercury derives moſt of its activity from its being in the ſtate of an oxid, for crude mercury poſſeſſes little or no power.* On the decompoſition of the water in which the medicine is given by the kali ſulphuratum, ſulphurated hydrogene gas is produced and conveyed into the blood, where the hydrogene unites with the oxygene of the acid menſtruum of the mercury, and forms water; while the ſulphur will convert the mercury into an ethiops which is very inert.—The benefit derived from hepatiſed waters, and from kali ſulphuratum in *colica pictonum*, ſome inſtances of which I have noticed in the laſt edition of my treatiſe on the Harrowgate waters, ſhows the great power of ſulphurated hydrogene gas, which probably renders the lead as well as the mercury inert.

The laſt winter, during froſty weather, I walked a good deal for ſeveral days. I at firſt found no bad effects from this exerciſe, but my ſpirits were remarkably good, and I found myſelf leſs affected by cold than uſual. My friends, however obſerved, that my countenance (which is naturally inclined to red) was more florid

* In the form of mercurial ointment, the mercury is evidently oxygenated by continued trituration.

florid than ufual. In a few days I was feized with a difficulty of breathing, great tightnefs in my breaft, and a fhort dry cough: I tried feveral remedies generally made ufe of, fuch as inhaling the vapour of water, blifters, opiates, &c. without relief. On reflecting that having ufed almoft conftant exercife, for many days, a much greater quantity of oxygene than ufual would be taken into the lungs by the increafed action of infpiration, (probably more than the increafed mufcular exertion required), and likewife that the barometer was very high,) and the air very cold at that time, both which circumftances would occafion the prefence of a greater quantity of oxygene in a given *bulk* of air, I imagined that my fyftem was fuperoxygenated. I began with taking about half a drachm of kali fulphuratum diffolved in water every two hours,—likewife diffolving the fame quantity in boiling water, and inhaling the vapours from it by means of Mudge's machine every hour. Before twenty hours had elapfed, I found the fenfe of tightnefs in the thorax confiderably leffened, fome degree of expectoration came on, and the cough was much relieved. In three days, by purfuing this method, my countenance became confiderably paler, and I found myfelf perfectly free from any complaint. Since that time I have prefcribed the kali fulphuratum in feveral cafes of florid confumption, and with confiderable relief; and in fome other cafes where there were evident marks of fuperoxygenation. In feveral of thefe cafes I have ordered a mixture of the kali fulph. and powder of charcoal, thinking if the charcoal could be conveyed into the blood, it might affift in diminifhing the quantity of oxygene, by uniting with it, and forming carbonic aid; at any rate, I thought that it might diminifh the quantity of

oxygene in the primæ viæ, and thus aſſiſt the ſulphurated hydrogene, by permitting a greater quantity of that gas to be conveyed into the blood; but whether it really does produce any good effects, I cannot poſitively ſay. That ſulphurated hydrogene gas is conveyed into the blood, and that either it or its ſulphur is given out by the excretorics, is, I think, evident from the urine of perſons who have drank the ſulphur water at this place, immediately rendering viſible characters written upon paper with a ſolution of ſugar of lead, on ſuch paper being immerſed in it: and likewiſe from ſuch perſons finding their watches and the ſilver in their pockets tarniſhed during the time they are drinking the water, though they do not at the ſame time uſe the bath. If you wiſh for an account of the caſes of conſumption in which I exhibited the kali ſulphuratum, I will ſend them.

When deficiency of oxygene occurs, as is the caſe in ſcurvy, typhus, &c. may not the oxygenated muriatic acid be uſed with great advantage, or perhaps the oxygenated muriat of pot-aſh would be ſtill better. We have here a large quantity of oxygene looſely attached to the ſalt, which would probably be ſoon ſeparated by the blood. Sir W. Fordyce's account of the efficacy of the oxygenated muriatic acid in typhus, ſtrongly ſupports the opinion.

I am, &c.

THOMAS GARNET.

Harrowgate, Dec. 13*th*, 1794.

Sir,

In the month of February, 1794, I was desired to visit Mr. L. of Knaresborough.—I found him extremely emaciated; he had a short dry cough, with very little expectoration; and the little which he expectorated was of the consistence of cream cheese; he complained constantly of a pain in the left side. His face, though pale, had a circumscribed spot on each cheek, of a fine florid colour; his tongue and lips were likewise very florid; he had cold colliquative sweats every night; his pulse, though small, was *sharp*, beating like a stretched cord, and he had a considerable degree of fever with exacerbations twice a day; his body was rather costive; his hair came off in great quantity on passing a comb through it, and his nails had in a great degree the curved appearance described by authors; in short, there was present every symptom characteristic of phthisis. He had been first attacked with these complaints about nine months before I saw him; they came on with symptoms of common catarrh. The expectoration was very considerable about six weeks before I saw him, mixed with streaks of blood, and remarkably fœtid. This discharge had gradually lessened, and become more consistent, attended with an increased difficulty of breathing, and pain of his side. I found upon inquiry that he was of a scrophulous family; and he told me that he was the only survivor of a large family, his brothers and sisters having all died consumptive. Before I saw him, most of the remedies generally used in such cases had been applied. Blistering, bleeding, myrrh, &c. had given him no relief, and his symptoms seemed aggravated by the bark and opium, which last, though given in doses of from one to three grains,

 produced

produced not the leaſt effect npon his troubleſome cough. I directed him to take a drachm of kali ſulphuratum, mixed with half a drachm of powdered charcoal four times a day in tea, and beſides to put a tea-ſpoonful of kali ſulphuratum into Mudge's inhaler, pour boiling water upon it, and inhale the vapour for a quarter of an hour at a time twice a day. When he had purſued theſe methods for two days, his breathing was ſenſibly relieved, and his cough was by no means ſo troubleſome; he expectorated more freely, and what he expectorated had more the appearance of bland pus. In a few days the expectoration became much leſs conſiderable and fluid; the hectic fever was leſs marked; the cough was much eaſier; he ſlept tolerably at night; and the florid ſpots on his face had nearly diſappeared. His pulſe, though ſtill 120, was much more ſoft; and though the perſpiration was free in the night, the ſweats were not cold and partial as before; his appetite was better, and his bowels quite regular. Encouraged by theſe appearances, I deſired him to perſiſt. In about a fortnight he found himſelf ſo much ſtronger, as to be able to walk about the room five minutes at a time, ſeveral times a day. One day during my abſence, being told that the weather was very fine, and the air very warm for the ſeaſon, he expreſſed a great wiſh to walk out, and continued in the open air for near two hours. In the evening the cough and pain of the ſide returned, and were more troubleſome than ever; he expectorated with difficulty, and in very ſmall quantity; the fluſhing of his face and ſweats returned. The powders were again had recourſe to, but did not afford much relief, though the expectoration became rather more eaſy. Bliſters and opiates did not cauſe any allevia-

tion;

tion; a diarrhœa came on, and after languishing about a week, he died. When I first visited him, he had been given over by his apothecary, who had left him, declaring that he did not think he could live till the morning. I myself did not think he could survive above a day or two.

April, 94.—I visited —— Byron, of Knaresborough, aged about 40, of a strong habit of body, and in general healthy.—After hard labour for some days in cold weather, he was seized with a difficulty of breathing, a short dry cough with but little expectoration, a great sense of heat, and face uncommonly florid; he was very restless and slept none; his pulse was 96, and rather full, and he had some pain in his right side. I directed about ten ounces of blood to be taken from the arm, and the application of a blister to the pained side, but he was not in the least relieved by them; the blood drawn was remarkably florid. In the evening I directed him to take a draught with 25 drops of laudanum, in hopes of relieving his cough, and procuring some sleep, but it did not produce the desired effect, he having a very restless night. Suspecting from appearances that the system was superoxygenated, I directed him to take a drachm of kali sulphuratum four times a day in a little tea. He took it four times the first day, thought himself somewhat relieved in the evening, slept better than he had done for several nights, his cough was much easier in the morning, he expectorated a little more freely, and the pain in the side was gone. He persisted in this plan two days more, and then found himself perfectly well.—An ingenious young friend of mine, Mr. George Birbeck, who is now a student at Edinburgh, was on a visit with me at the time, saw the patient along with me, and was surprised

at the quickneſs of the cure. Similar caſes are often met with among labouring people in this pure air; and I muſt own that they have often perplexed me. I have generally found that no remedy affords permanent relief; but that the diſeaſe gradually goes off in ten days or a fortnight, if the patient will confine himſelf to his chamber, and more particularly to his bed. I hope, however, that I have it now in my power to ſhorten its duration. No doubt if the patient could have an opportunity of inhaling hydrogene gas, it would alſo remove the complaint.

I am Your's, &c.

Letter from Mr. SANDFORD,
On the internal uſe of charcoal.

DEAR SIR,

As every additional fact in ſupport of a practice which (if we may judge from the rapid ſale of publications on pneumatic medicine) begins to be generally known, if not adopted, may induce medical men to extend their experiments, the two following obſervations are at your ſervice for the new edition of your pamphlet.

S. C. æt. 34, has been for upwards of three years affected with a carcinoma of the *os uteri*, and has ſcarcely ever for a long time paſt been free from pain, attended by a moſt fœtid diſcharge. She has at differ-times uſed fomentations of hemlock, and pills of the ſame, with opium; but nothing has given her much relief for the laſt ſix months preceding the application of charcoal. The charcoal is made into a very ſtiff

paſte

paste with honey; the vagina is filled with this composition the last thing at bed-time; to secure it in its place a soft cloth doubled is applied to the os externum and retained by a T bandage. In the morning the parts are washed by injecting yeast and warm water. Three or four successive applications of this mixture have *always* removed the pain, corrected the fetor, and *frequently* made the patient easy for weeks. More might possibly be done for her by these means if she were not kept in almost constant drudgery by the nature of her occupation. Since the application of charcoal, however, she feels better satisfied in her situation than the preceding three or four years of her life, having been so much less harrassed by her complaints.

A. H. aged 50, of an asthmatic habit, and subject to a severe cough, with expectoration so fœtid and gross as to persuade herself and her friends that she is truly consumptive. The cough goes off after expectoration, and on a sudden change of weather returns by paroxysms. She had taken variety of *expectorants* and *anti-spasmodics*. But her symptoms have been far more considerably relieved by a dram of charcoal in fine powder, made into a bolus with honey, taken thrice a day, and washed down with warm milk and water. This eases the cough, and removes the disagreeable smell of the expectoration. It has repeatedly done so in a few days whenever she has had recourse to it. *So far* it has been certainly useful; and she now flatters herself that by longer persisting in its use she shall be completely cured.

The

The diseased nose, which was reduced by the application of charcoal,* continues perfectly well; and I cannot help expressing my satisfaction at finding yesterday Dr. Ewart's patient ALFORD (of whom so much has been said in our periodical publications) kept completely easy by carbonic acid air. Next to a radical cure (which in many cases may possibly be effected) it is surely the most desireable of all things to have the means of stopping the progress and keeping off the pain of ulcerated cancers for months, and probably years.

I am, &c.

W. SANDFORD.

Worcester, Jan. 19, 1796.

Letter from Mr. WILLIAM SANDFORD.

Worcester, Feb. 20, 1795.

DEAR SIR,

Among the variety of patients that apply for surgical assistance, those afflicted with putrid ulcers form a principal part; the laws of most hospitals forbid their admission as in-patients; but compassion frequently suspends the operation of these laws; and it is a melancholy truth, that the general poverty, inattention, and improper conduct of out-patients, often counteract the means directed for their relief.

I cannot flatter myself that success will invariably attend the application I am about to recommend for putrid

* See Mr. Sandford's Account of this interesting case, in CONSIDERATIONS Part III.

putrids ulcers and mortifications; but my own experience has proved it to be efficacious in ſome of the worſt of theſe caſes, and I can add the reſpectable teſtimony of my colleagues, Mr. Jeffreys and Mr. Cole. I feel ſatisfaction in communicating my obſervations to you as they are fundamentally connected with a ſyſtem of medical practice, from which you have ſhewn by experiments, that great expectation may be juſtly entertained.

Accounts of the good effects ariſing from the external application of charcoal in a ſtate of combination, or in that of fixed air, have been publiſhed by Mr. Juſtamond, Dr. Percival, Dr. Dobſon, and more recently by the ingenious Dr. Ewart, of Bath. Various periodical publications of modern date, have made the efficacy of charcoal in ſweetening putrid ſubſtances ſufficiently known. Dr. Johnſtone of this city, informs me, that he has found this ſingular ſubſtance mixed in the proportion of two drachms with two ounces of ſyrup of roſes, to be very ſpeedily efficacious in removing apthous, and putrid ulcerations of the tongue and palate. I have been likewiſe informed of ſeveral caſes in which charcoal has been adminiſtered with ſucceſs as an internal medicine.

In private as well as public practice, it has long been cuſtomary to apply fermenting mixtures to ſphacelated or mortified parts. Mr. Ruſſel and Mr. Jeffreys of this city, whoſe extenſive practice has afforded them many opportunities of obſerving its effects, aſſure me (and particularly the former) that they have found no application ſo generally uſeful as yeaſt in every ſpecies of mortification, attended with an offenſive diſcharge, except that which Mr. Pott has ſo well deſcribed

ſcribed as taking place in the extremities of old people. Mr. Jeffreys informs me, that many years ago it was his cuſtom to apply to putrid ulcers ſtupes wrung out of the common fomentation, and ſprinkled with *ſpiritus mindereri* in a ſtate of effervefcence. The effects, he adds, were beneficial; and the books of the Worceſter infirmary ſhew, that he followed this practice in 1751. The late Dr. Cameron and Mr. Edwards alſo employed it with great ſucceſs, as far back as 1759. The real efficacy of fermenting applications, depends, perhaps, ſolely on the quantity of fermenting matter they contain; in other words, of carbonic acid generated, and has no connection with ſeveral articles introduced by the fancy of different practitioners.

If the opinion be juſt, we ſhould expect that the effect of fermenting applications, and of the carrot poultice among the reſt, would ceaſe with the production of carbonic acid air; and this really appears to be the caſe. But by the application of charcoal, not only is the putrid condition of the ulcer corrected, but pus of a more bland nature is generated, the granulations are much quicker in their growth, and the diſpoſition to heal is much quicker after this than after any other dreſſing I have ſeen employed. The granulations, indeed, frequently after a ſhort time, become very luxuriant, and require early preſſure to ſuppreſs their growth.

Putrid ulcers, as I have been credibly informed, have been conſiderably benefited by charcoal ſtrewed in fine powder on their ſurface; but of this I cannot ſpeak poſitively from experience; for the pain which it ſeemed to occaſion on ſeveral trials, induced me to lay it aſide, and to have recourſe to the following cataplaſm.

Mix

Mix as much oatmeal and water as appear neceſſary to form a poultice large enough for the part affected. The conſiſtence, after they are well boiled, ſhould be rather thinner than the ſtate in which poultices are generally applied; becauſe it is to receive a large quantity of charcoal, which ſhould be very finely powdered and ſifted. The charcoal ſhould be added, when the poultice is nearly cool enough to be applied, in ſuch proportion as to give the whole a pretty firm conſiſtence, ſince after 6 or 8 hours application it becomes very liquid, particularly if the diſcharge be conſiderable. The poultice, when made, ſhould be ſpread upon a ſoft linen cloth, much larger than the ſpace occupied by the poultice. It will perhaps be thought unneceſſary to inſiſt upon equal ſpreading, or upon making the edges as thick as the centre; but this precaution is too often neglected.

The poultice, after being properly ſecured, muſt be ſuffered to remain at leaſt 12 hours; and unleſs the diſcharge be great, it need not be removed in leſs than 24; and a freſh poultice ſhould always be in complete readineſs before the other is removed; the part ſhould not be wiped more than neceſſary, and that the atmoſphere might not affect the ulcerated part, the poultice ſhould be applied as quickly as poſſible.

When the edges are ſoftened and look healthy, when the effluvia are corrected, and good pus appears on the ſurface, the poultice may be laid aſide. Any other application which the ſurgeon ſhall think likely to promote cicatrization, may be ſubſtituted in its ſtead. I have experienced nothing more generally uſeful than to dreſs the edges with mild cerate, and very plentifully to ſprinkle over the face of the ulcer a fine

a fine powder, composed of two parts of Peruvian bark, one of calcined zinc, and one of myrrh.

In mortifications the poultice must be continued till the sloughs or unsound parts are completely thrown off.—These means, with gentle pressure, generally effect a cure. In one or two instances, where the poultice has been laid aside too early, the ulcers have put on their former ill conditioned appearance, which, however, on returning to the charcoal, has immediately changed for the better. I should not omit to insist with Dr. Crell, on the necessity of carefully preparing, finely powdering, and keeping in clean vessels the charcoal. It adds much to the efficacy of the poultice, if a *very* small quantity of yeast be occasionally spread on its surface.

The following are a few, out of many cases, in which the cataplasm, thus prepared, has been successfully employed. If it be found equal in efficacy to any hitherto imagined, its cheapness seems to give it a claim to be adopted in hospital practice.

Case I.—T. B. Æt. 64, was admitted an in-patient of the Worcester Infirmary, November 23, 1793, as a case that required immediate attention; a mortification of the right leg having taken place, which extended from the middle of the upper part of the foot, to about three inches below the knee; a separation of the unsound parts had in some places commenced, but the discharge, which was slight, was highly offensive and putrid; the back part of the leg, where no ulceration had taken place, was livid, cold, and insensible.

He was immediately put into bed, and the limb laid in a large carminative poultice of the hospital, com-

posed

poſed of bay-berries, &c. in which yeaſt alſo formed a principal part. The next morning I ſaw the patient with Dr. John Johnſtone; he informed me that he had heard of charcoal having been applied externally to mortified parts with great ſucceſs; and as he conceived the preſent caſe was a favourable one for the trial of its effects, it was immediately applied in the form of poultice, prepared in the manner before deſcribed. — Though the leg looked better after the application of the poultice with yeaſt, yet the change after the charcoal had been twice applied (which it was in the courſe of 24 hours) was as favourable as it was rapid. By the time the poultice had been 7 or 8 times applied, a compleat ſeparation of the diſeaſed parts took place; bland pus was produced, and the edges of the ſound parts appeared healthy and clear; as the application was continued, the leg in the courſe of a few days loſt its livid aſpect, and was warmer and more ſenſible to the touch.

Some of the ſloughs, particularly upon the upper part of the limb, when digeſted clearly off, expoſed the tibia; the perioſteum ſloughed a little, but granulations ſoon made their appearance, without any exfoliation of the bone; to this part of the leg therefore the poultice was ſoon diſcontinued, and mild dreſſings ſubſtituted in its place. The exterior tendons of the foot were laid bare when that part ſloughed: but this, as well as other parts of the limb, was ſoon clear, and preſented a healthy and granulating ſurface; but ſo large a portion of the true ſkin having been deſtroyed by ulceration, *rendered* the healing proceſs long and tedious. The patient, during the firſt month, took the Peruvian bark in as large doſes as his ſtomach would

bear,

bear, together with half a pint *only* of port wine made into negus, in the courfe of 24 hours; afterwards he was allowed two pints of porter per diem, and his dofe of bark was leffened: he was difcharged cured, excepting a trifling ulceration upon the inftep. — *February* 1ft, 1794.

CASE 2.—I. P. æt. 60, came recommended to the Worcefter infirmary, as an out-patient, Aug. 2, 1794, for a large putrid ulcer of the left leg, with which he had been afflicted upwards of 4 years; at this time the difcharge was fo acrimonious as to excoriate the leg in different parts near the ulcer, which was attended with fwelling, pain, and inflammation. Being judged in too bad a ftate to receive much benefit as an out-patient, he was admitted into the infirmary; he took a dofe of calomel the night of his admiffion, and next morning a dofe of Glaubers falts, and the ulcer was covered with a thick poultice of charcoal. When the firft poultice was removed, which was not till the expiration of 24 hours, the furface of the ulcer appeared more favourable, and the quantity of the difcharge was altered for the better; he repeated the dofe of calomel and faline purgative twice again within the fpace of 8 days, and the poultice was renewed every day for a fortnight longer; a large flough was then thrown off from the ulcer, and granulations made their appearance from the bottom, but the edges remained rather callous; thefe parts were dreffed with mercurial ointment, and the face of the ulcer with the aftringent powder. The ulcered part filled up in due time, and the man was difcharged perfectly cured.—— *October* 4.

CASE 3.—I. F. æt. 24, a ſoldier belonging to the Scotch Greys, quartered in this city, was admitted an in-patient of the infirmary October 25, for a large ill-conditioned ulcer of the leg, which was at that time in a very putrid ſtate. Immediately upon his admiſſion, the charcoal poultice was applied. When the ſlough of the ulcerated part firſt began to ſeparate, it appeared more deeply attached to the ſound parts than any I ever remember to have ſeen, except in the patient (No. 5) and which was produced by mortification in an old ſubject; the degree of inflammation in the ſurrounding parts of the ulcer was very great; he was bled freely, and took ſaline medicines for ſome time; the charcoal poultice was applied to the ulcer, and continued till the ſlough was completely ſeparated and digeſted off, which took place in about 6 weeks, when the cerate edging and aſtringent powders were made uſe of, and would moſt probably have completed the cure, had the patient paid more regard to his conduct; but having twice abſented himſelf from the infirmary without leave, and coming home intoxicated, I was obliged to diſcharge him for irregularity. —— *December* 26.

CASE 4.—J. I. æt. 24, another ſoldier belonging to the ſame regiment, was alſo admitted an in-patient of the infirmary, November 15, 1793. He had a very large and painful ulcer about the middle of the leg, extending acroſs the tibia, which had been healed at different times, and from ſlight accidents had broken out again. At this time the edges were callous, and the ſurface of the ulcer remarkably foul, with a greeniſh aſpect, and attended with conſiderable inflammation of

of the ſurrounding parts. The charcoal cataplaſm was applied to the ulcer, and he took every third day a ſolution of Epſom ſalts for the firſt fortnight.

The ulcer, ſoon after the firſt week, loſt its offenſive ſmell, and the ſurface appeared clearer, but no granulations ſucceeded, nor were the callous edges at all ſoftened. I then laid aſide the poultice, and applied mild digeſtives, with the gentle preſſure of a flannel roller. Still the ulcer continued in a very ill-conditioned ſtate, and without the leaſt ſign of further amendment. About this time having ſome reaſon to ſuſpect his conduct, and hearing from the nurſe of ſome ſuſpicious circumſtances with regard to his linen, upon being queſtioned, he confeſſed, that he then laboured under an inveterate venereal complaint.

I then immediately altered my preſent mode of treatment, gave him mercury by the mouth, and dreſſed the ulcer with mercurial ointment, which ſoon produced an appearance for the better.

This caſe exhibited ſtrong proof of the efficacy of the charcoal, in removing the fœtor, and clearing the ſurface of the ulcer—more could not *here* be expected from it, for reaſons too well known to be alledged.

The man was now made an out-patient, and ſoon after after having ſome money left him by a relation, he purchaſed his diſcharge from the regiment, and I ſaw no more of him.

CASE 5.—As there are ſome remarkable circumſtances attending the cauſe that required the application of the charcoal poultice in this caſe, I ſhall take the

the liberty to treſpaſs a little upon your time in relating them.

F. M. æt. 60, was brought to the Infirmary Oct. 30, with a ſimple fracture of the left leg, occaſioned by a bull treading upon it, he having unfortunately fallen down whilſt endeavouring to ſecure the animal for ſlaughter; by which accident the fibula was tranſverſely fractured immediately above its formation of the outer ankle. The accident happened about five miles from Worceſter, and his friends, from an over officiouſneſs, which, though well meant, was ill directed, bound a narrow liſt garter ſo *very* tight round the fractured part, as to preſs in the ends of the bone, and act like a tourniquet on the parts below; he was brought in this ſtate to the infirmary 6 or 7 hours after this misfortune had befallen him. The limb below the bandage appeared perfectly livid, and above it, highly inflamed and much ſwelled. The bandage (which had a little excoriated the ſkin) was immediately taken off; a ſaturnine poultice was applied to the leg, and a ſolution of Epſom ſalts was ordered to be taken. This was at night; I ſaw him next morning, and the limb looked then very unfavourably: the poultice was now laid aſide, and linen cloths wet with a mixture of ſpirit minder and ſpirit of wine were kept conſtantly upon the part. The day after, veſications appeared near the fracture, with every other appearance of gangrene having taken place; which in the courſe of a day or two terminated in a large ſphacelated ulcer immediately over the fracture, which extended about three or four inches in circumference, diſcharging a putrid and highly offenſive ichor. At this time Dr. Cameron ſaw him with me, and the

 cortex

cortex was given him in the form of cold infusion, with a small quantity of the tincture in each dose; he was also directed to take half a pint of port wine made into negus, in the course of 24 hours. His stomach bearing the present mixture so well, I then gave him a mixture with extract of common oak bark, (quercus) a preparation that Dr. R. W. Darwin, some years past, informed me had been applied externally with good effect to scrophulous ulcers; for which purpose I have often found it serviceable; and since that time I have very frequently given it *internally*, in most of these cases where the Peruvian bark seems indicated.

Dr. Lewis remarks, that "an extract made from "oak bark, is said by some to be equal in virtue to "that of the Peruvian bark."—(*See Lewis's Mat.* "*Medica*, p. 474).

I have experienced equally good effects from this extract, (if joined with an aromatic) as from that of the true Peruvian bark. Some of the physicians of this infirmary have also lately prescribed it with very beneficial effects. With this patient it agreed remarkably well, improved his appetite, and supported his strength, which had been greatly reduced. This man's case seemed to prove, as clearly as any I have met with, the ingenious theory advanced by the late Mr. Hunter, that the "mortification which is preceded by inflammation, is produced and accompanied with increase of action and loss of power."—(*See Hunter on the Blood, Inflammation*, &c.—)Hence the necessity of giving the cortex, or some similar tonic, in as large doses as the stomach will bear, and no more alcohol in any form than is merely sufficient to keep up the *necessary* action, and thereby prevent its *excess*.

But

But to return to the ſituation of the limb—the ſame day the bark was adminiſtered intern.lly, the charcoal cataplaſm was applied to the mortified parts, and daily renewed at firſt twice, and latterly only once in the 24 hours, till the whole of the ſlough, which was large and deep, was entirely ſeparated and thrown off. When this was effected, the fibula was laid bare, and the fractured part expoſed to view; it was then of courſe to be treated as a compound fracture, and cured by the ſecond intention; the poultice was now diſcontinued; the edges of the ulceration dreſſed with epulotic cerate, and the centre with doſſils of lint dipped in a mixture compoſed of equal parts of *mel. roſar. tinct. myrrh*, and *decoct. cortic. Peruv.* Granulations ſoon appeared; a ſlight exfoliation took place, and the cure went on perfectly well. The man is now able to walk about with the aſſiſtance of a ſtick, and the motion of the foot (which I feared would have been deſtroyed by ſuppuration) has been fortunately preſerved, and is recovering its action.

Case 6.—J. H. æt. 27, was admitted an in-patient November 15, 1794, having a large putrid ulcer of the right leg, about the middle, and acroſs the tibia; he had been afflicted with it for more than two years, and it had been in its preſent ill-conditioned ſtate upwards of three months; he had dreſſed it with variety of unguents of different kinds, and at this time it had every appearance of approaching gangrene. The charcoal poultice was immediately applied to the ulcer, and he took the extract of oak bark in the proportion of 15 grains to an ounce and half of ſaline mixture; to each doſe of which $1\frac{1}{4}$ drachm of aromatic tincture was added every ſix hours. This plan he continued with little alteration for upwards of a month before the ſlough

was completely ſeparated ; when this was thrown off, the poultice was laid aſide, and the ulcer treated as before mentioned. The ulcer, from the luxuriance of its granulations, required the preſſure of lead to aſſiſt in the cicatrization.

Case 7.—(Mr. Cole's patient).—O. C. æt. 20, was admitted an in-patient of the infirmary, for a compound diſlocation of the ankle, which had been in ſo bad a ſtate for ſome time previous to his admiſſion, that it was judged neceſſary to amputate the leg, which was accordingly removed at the uſual part below the knee. The man underwent the operation very well. The lips of the ſtump were brought together by ſtrips of adheſive plaiſter, to be healed (as is now generally practiced, I believe) by the firſt intention.

Four days after the operation, the ſtump and thigh appeared much ſwelled, though the bandages were by no means tight. I happened to be in the ward when Mr. Cole removed the dreſſings, and examined the ſtump, the lips of which had receded, and expoſed the face of the ſtump, which we were ſurprized to find in an highly offenſive and gangrenous ſtate; added to this unpleaſant appearance, the patient's countenance was pale and ſunk, and his pulſe quick and tremulous.

Mr. Cole immediately ordered him a ſaline mixture with the cortex, and port wine negus occaſionally ; a thick charcoal poultice was alſo applied to the face of the ſtump. In leſs than 48 hours every unpleaſant appearance was changed for the better, a good digeſtion came on, and the cure was by theſe unfavourable circumſtances protracted for a ſhort time. The patient ſoon loſt his fever ; recovered his ſtrength ; and the ſtump did well.

In

In this caſe, it was not found neceſſary to continue the charcoal poultice for a longer time than three or four days.

Having informed Mr. Field, who attends the invalids in the houſe of induſtry lately eſtabliſhed in this city, of the good effects of the charcoal applications, he has in conſequence applied it to ſeveral putrid ulcers of the legs, &c.—in ſubjects from whoſe age and other infirmities, little hope of relief was to be expected.

He aſſures me it has *never failed* to effect a ſpeedy and favourable change, by correcting the putrid diſcharge, and producing healthy granulations, with a bland and well digeſted pus.

Two of the caſes in which he has applied it I think merit particular attention. The one was a cancerous ulcer of the ſide (the breaſt having been removed ſeveral years paſt at the infirmary) extending deep under the axilla. Mr. Field applied the charcoal in *fine powder*, which he ſprinkled very freely over the face of the ulcer, firſt ſmearing it with a very ſmall quantity of yeaſt. In a few days it removed a moſt offenſive fœtor, and procured a healthy aſpect of the ulcer, with a diſcharge of mild and inoffenſive matter. The arm of this patient on the diſeaſed ſide, after ſwelling to an enormous ſize, became gangrenous, and a mortification ſucceeded, with putrid and deep ſloughs from the wriſt to the elbow ; the ſame mode of application was adopted with the hope of removing the intolerable fœtor. Though it was conceived the patient could not live many days, being upwards of 60 years of age, and very much reduced by the pain and long continued diſcharge of the ulceration, the progreſs, however, of the

the mortification, which ſeemed extending upwards toward the ſhoulder was immediately checked; in a very few days the ſloughs completely ſeparated, leaving healthy granulations, and the wound, though a very large one, is filling up as kindly as could be expected in a younger or healthier ſubject.

The other was a woman upwards of 50, who, from long confinement to bed, and the effect of conſtant and unequal preſſure, had a deep ſlough formed upon one of the nates, which was dry, perfectly inſenſible, and without any diſpoſition to ſuppuration.

The charcoal powder was applied here as in the former caſe, and retained by a large piece of leather, the edges of which were ſpread with adheſive plaiſter; in leſs than a week a complete ſeparation had taken place, when a dreſſing of mild digeſtive effected an eaſy and ſpeedy cure.

In neither of theſe caſes did the patients complain of any increaſe of pain from the application.

No medicine was given to the laſt; and in the firſt caſe nothing more than a few grains of extr. cicutae, with about 20 drops of tincture of opium at bed-time.

In ſome caſes in which I am now applying charcoal powder, no pain has enſued. The yeaſt has been added in theſe caſes; and it operates as effectually as the cataplaſm.

Believe me, dear Sir, &c. &c.

WILLIAM SANDFORD.

To Dr. Beddoes.

Letter

Letter from Dr. JOHN JOHNSTONE.

Birmingham, Feb. 14, 1795.

DEAR SIR,

Herewith I ſend you an abſtract of trials of ſome of the chemical ſubſtances; I began to make them early in the year 1793, after having ſeen the relations of M. Lowitz and Kels. Many of the experiments of both theſe gentlemen I repeated, and others were inſtituted to ſatisfy my mind on ſome topics relating to putrifaction, a ſubject till lately involved in much darkneſs, and concerning which, our knowledge at preſent is far from preciſe.

Long before the time of M. Kels, Macbride had diſcovered, that the aerial product of fermentation, rectified the ſmell and taſte of putrifying bodies; and there are many accounts of its ſervice in diſeaſes, recorded in the 4th vol. of Prieſtley on air, and in Dobſon's Commentary. But this power, though poſſeſſed univerſally by the carbonic principle, is not confined to it. Subſtances containing oxygene, have it probably in a greater degree. Half an ounce of nitre will produce a more inſtantaneous effect on the ſame quantities of putrid fluids or fleſh, than an ounce of powdered charcoal. The ſame holds good with reſpect to many other oxygenated ſubſtances. The hyper-oxygenated acids, deſtroy putrid ſmells, in very ſmall proportion.

By theſe leading facts, and by many others which it is unneceſſary to detail, I conceived myſelf authorized to make trial of the ſubjects of them, in caſes of diſeaſes which ſeemed to bear any affinity to the proceſs

of

of putrefaction. These trials I shall here class together, without any respect to the order of time in which they were made, though many of them were made or improved, since I came to this place in the last Autumn, in conjunction with my brother, Dr. Edward Johnstone.

ULCERATIONS. — In hardly one case of foul ulceration of the extremities have I been disappointed in the application of carbon, though it has been applied in a vast number of cases under my inspection. Whether in the form of powder or of liquid (yeast), it universally renders them clean. In the case of Nurse Purton, an old woman of 80, a patient in the Worcester infirmary, and who had been afflicted with a sore leg for almost half a century, the carbon cataplasm never failed to cleanse the wound, though the application sometimes gave pain.

During the Autumn of last year the measles assumed a peculiarly putrid appearance in the town of Birmingham and its neighbourhood. Children were generally affected with a very offensive and obstinate diarrhœa, during their continuance, and towards the close of the disease with very foul ulcerations, spreading about the face and mouth. In the case of a girl of 8 years old, the right cheek was much swelled, and the inside of the mouth was occupied by a foul spreading ulcer. Various unguents had been tried in vain, the ulcer spread, became black, and every day assumed a worse appearance. The change for the better was very quick after the application of the carbon, and the ulcer soon healed. From the same cause, the roof of the mouth, and the upper gum of an infant were in a dreadful state, in part eaten away, and excessively foul. A paste

composed

composed of charcoal powder and yeast was ordered to be applied, and was effectual in healing the wound, though the structure of the parts will probably be never entirely restored.

In two cases of mortification, one of the leg in a man of fifty, the other in the thigh of a young boy, the application of the carbon was most satisfactory. In the first case the wound extended all over the foot and and nearly up the leg: The sloughs began to separate the next day after the application. In the case of the boy the separation of the sloughs was succeeded by universal erysipelas. Both patients took bark and I believe nitre internally, and both recovered.

To scrophulous ulcers I have applied carbon in several cases, as well as given it internally, but never with permanent benefit. I have also given these patients nitre in large doses, at the same time that the ulcers were covered with carbon, and with no better apparent effect.

Cancer.—In one case in which a cancer occupied the whole breast, and had spread towards the neck, eating it into foul ulcerations, the carbon powder was applied. The appearance of the wound was much mended; it became clearer and looked redder, but no permanent relief was obtained; and sometimes there was a great deal of pain.

In a cancer of the os uteri, after various trials, I directed a paste composed of carbon powder and yeast to be applied by a pessary to the part. There was some inconvenience in the application, though the patient complained much less of it than of the fumes of cinnabar,

nabar, which had been previoufly adminiftered. She could not be prevailed upon to perfift in its ufe.

Cutaneous Eruptions.—The face of Poole, a patient in the Worcefter Infirmary, was covered with a dark-coloured reddifh blotch, which was painful and fpread. Her right arm was covered with the fame fpecies of eruption, particularly about the elbow, where there were feveral fores. She hod thefe complaints many years, fometimes more, and fometimes in a lefs degree. I dieefted the carbon cataplafm to her arm, and to wafh her face with yeaft frequently. The effect was very fatisfactory, as fhe had previoufly employed mercurials and many other means without benefit. The ulcers healed in a fhort time, and the eruption in great meafure vanifhed.

In two cafes of Erythema without ulceration, after the meafles, yeaft was applied with the beft effect, the eruption difappearing in the courfe of a day and night.

The progrefs of pimples upon the face is generally ftopped by wafhing them often with yeaft. They grow livid after a few times wafhing, and foon difappear. I fubmit it therefore to my fair countrywomen, whether it may not become a much more ufeful cofmetic than milk of Rofes, or of any thofe doubtful preparations fo commonly ufed.

Erysipelas.—In feveral cafes the carbon was ufed both by my brother and myfelf with complete fuccefs. In the cafe of Mrs. H———, it was very threatening, as it fpread very much about the face, accompanied with delirium. My brother ordered her face to be wafhed with yeaft frequently, and to take bark internally. She recovered in three days.

In

In cafes of fcarlatina and angina maligna, I now generally direct yeaft to be ufed in gargles, and to be rubbed upon the fkin. In repeated inftances I have found this plan ufeful, exhibiting at the fame time occafional emetics, with nitrous mixtures.

In phthifical cafes, when the night fweats were urgent, I have for fome time paft directed yeaft to be taken in the quantity of a large fpoonful, or two large fpoonfuls in milk, three or four times in the day. It generally appears to be ferviceable at firft, but I have feldom found its good effects permanent. In one cafe I think it fucceeded.

TYPHUS.—In two inftances I had the opportunity of trying the carbon fully.

The firft, a foldier, had been very improperly treated with antimonials previoufly to my feeing him. His debility was extreme with occafional delirium; his tongue black and parched; his ftools offenfive, and he could keep nothing upon his ftomach. The bark in all forms was vomited up. He firft of all took a faline effervefcing mixture, which ftaid upon his ftomach. He afterwards took one ounce of charcoal powder three times a day, with port wine and water, and 15 drops of laudanum at night. The foulnefs of his tongue and the vomiting foon difappeared, and he recovered flowly, occafionally taking bark.

In a girl of 14, the fmall-pox affumed the worft appearances. The eruption began on the third day, with great fever, violent pain of the head and fide. A blifter was immediately ordered, which gave eafe, and fhe took fome opening medicines. The next day, after the blifter had arifen, the puftules fhewed no elevation,

vation, and every ſymptom clearly indicated that the diſeaſe was in the worſt degree. Her ſtools were offenſive, and the debility extreme. I ordered a drachm of charcoal powder to be taken every four hours, with a mixture of decoction of bark and yeaſt, and that ſhe might have as much port wine as ſhe liked, and freſh ale. This plan was perſiſted in, with bliſters occaſionally for nine days, at which time the patient died, with more marks of putrefaction than I ever ſaw before. Her body was univerſally black, and at a ſmall diſtance ſhe looked like a negro. She drank great quantities of the freſh ale, and during the two days before her death, 3 pints of port wine. Purple ſpots appeared on the thighs about ten days from the beginning of the diſeaſe, which vaniſhed on the application of a paſte of charcoal and yeaſt. I much regret that ſhe was not waſhed all over with yeaſt, but I confeſs this circumſtance did not occur to me. After the full trial of the carbon in this caſe ſo unſucceſsfully, I have never truſted to it ſolely in any of thoſe diſeaſes in which the powers of life are ſo exhauſted as they are in typhus. I believe it may be uſeful to correct the filth that accumulates in the mouth and in the inteſtines, but it certainly is not to be truſted to alone for their cure. Subſtances containing oxygene are infinitely more appropriate for this purpoſe, and ſhould be employed. Nitre contains oxygene in great abundance, and has been uſed with advantage in typhus. But its uſefulneſs in inflammatory diſeaſes, and indeed its effects when taken as a poiſon in large quantity, make me ſuſpect, that the baſis of the acid contains a power capable of abſtracting from vitality. On this ſuppoſition we may account for the contradictory effects aſcribed to it. But the conſideration ſhould make us look

look out for other ſubſtances that are not contaminated with any powers contrary to thoſe for which we wiſh to employ them. The oxides of* manganeſe have occurred to me as likely to anſwer the end I have given them in very large doſes to healthy perſons, and have ſwallowed them myſelf without the leaſt apparent injury. On this ſubject, however, I ſhall not enlarge, and I will only add one more ſpeculation to what is already perhaps too long.

From the notions that I entertain of the nature of the gout, I have been led to ſuppoſe that the inſpiration of an atmoſphere above the common ſtandard might be ſerviceable for its cure. If the diſeaſe ariſe in the firſt place from a deficiency of oxygene in the blood of the arteries of the extremities and the chain of ſymptoms be induced by this deficiency, certainly an hyper-oxygenated atmoſphere is the remedy to be adopted. But this is all hypothetical, and I ſhall content myſelf with having given the hint, without purſuing the ſubject further.

This is what I know of the effects of carbon; it is imperfect as every abſtract muſt be, but it is faithful as far as it goes; and it would have been impoſſible to have comprehended within the room that you could ſpare, the caſes in their full extent.

I am, dear Sir, &c.

JOHN JOHNSTONE.

* I have been lately informed that Dr. Macdonnel of Belfaſt has uſed this oxid with great advantage as an application to certain ulcers. T. B.

Dusting-Box.

Several years ago, Dr. Darwin contrived the apparatus, delineated plate 4, fig. 3, with intention to apply substances, that might be supposed capable of a salutary action, to the ulcerated surface of the lungs. The facts in the preceding communications and some others, together with the present disposition of the public to favour attempts towards the cure of consumption induced me to apply for permission to insert a sketch of this little machine in this pamphlet. Whether it will be useful to coat the pulmonary ulcers with fine charcoal, calx of zinc, any of the preparations of lead, Peruvian bark, or some such composition as Mr. Sandford mentions, remains to be tried. The box may be 10 inches high and 8 square. It has within a circular lath brush, with a cross bar of wire, against which the bristles of the brush, loaded with dust, successively strike; the dust is thus spirted up through the mouth-piece, and the patient inhales it at his convenience; and I have lately found that this method may be followed to any extent without coughing being excited. The structure of the box will easily be understood from the plate. On seeing this contrivance, another person thought that a *powder-machine*, formerly more in use for the waste of wheat than at present, would very well answer the purpose; this is represented fig. 4.

Observation on the effect of charcoal, in correcting rancid eructations.—Extract of a letter.

—My dyspepsia was not attended with much flatulence or heartburn, but was very troublesome after eating any strong dish, such as goose, garlic, or cabbage, from a rising of rancid matter from the stomach, perhaps every

every 5 minutes. This was always *immediately* checked by a table ſpoonful of very fine ground charcoal—ſo much ſo that the next eructation would be ſcarcely offenſive; and in a little time the ſtomach was completely ſet to rights. Several perſons in our family have received benefit from it in the ſame way.

Having had no ailment in the ſtomach for a long time, I cannot ſay that I have had *much experience.* — Perhaps I may have been relieved a dozen times, and I think I never took it without a very ſenſible effect. I do not believe it has much effect on the bowels; it is aperient however, rather than otherwiſe. As to your queſtion of prevention of wind, mine was ſo little a caſe of flatulency that I cannot ſpeak very poſitively of its virtue in that particular. It certainly, however, had this effect to a certain degree. Upon the whole, I have not the ſmalleſt doubt of it being a very uſeful family medicine.

I am, your's, &c. —— ——

To Dr. Beddoes.

I inſert this obſervation with the greater pleaſure, from the hope that it might take away one excuſe for dram-drinking. I ſtrenuouſly recommend it to perſons whoſe ſtomachs are weak; as alſo to perſons apt to overload a ſtrong ſtomach, to have in readineſs ſome fine powder of charcoal, and to take it inſtead of wine or diſtilled ſpirit, to prevent food from *repeating*. It may be prepared by burning corks perfectly and thoroughout black, and then rubbing them to powder. This preparation is uſed in ſome places for the cholic in horſes; but as it is given in fermented liquor, its power is ſomewhat dubious. I have been informed

by

by another intelligent correſpondent that he has found charcoal gently aperient; an obſervation which ſeems well worth attention.

Mr. Capper's deſcription of his apparatus for experiments on brute animals.

The letters k, l, m, n, pl. 5, repreſent the wooden chamber, which is dove-tailed to make it air-tight; the ſize may be varied according to the ſize of the animal which is deſtined for experiment. The one from which the plate is taken, is three inches and a half, by four and a half.

The letters i, j, k, l, repreſent the mouth-bag, which is of oiled ſilk nailed on the chamber at b: but before you put them together, glue on a narrow ſtrip of leather; when the glue is dry, plait the oiled ſilk; and as faſt as you plait, nail on a narrow ſtrip of leather, ſimilar to the one underneath; the plaits ſhould be very ſmall, and the nails of courſe very cloſe to each other. The mouth-bag is eaſily ſecured round the mouth of the animal by means of tape, uſed as a ligature.

The letters m, n, o, G, repreſent the bag which contains the air to be inſpired, and is nailed to the chamber in the ſame manner as is deſcribed. G is the aperture thro' which the bag is filled; h the inhaling valve (at the bottom of the chamber) made of very thin wood, covered with leather, which being extended on one ſide farther than the wood, (and this being glued to the chamber), ſerves as a hinge to the valve. At d is the exhalting

exhaling valve, made and ſecured (but on the outſide of the chamber) in the ſame manner as the other.

When you fill the bag, the valve at the bottom of the chamber muſt be preſſed down with the finger, to prevent the eſcape of the air.

At G the ſilk ſhould be lined with ſoft leather, otherwiſe it will ſoon be worn out by the frequent uſe of the ligature.

The manner to make the ſilk air-tight, is by ſowing weak leather within the ſeam, and then covering it with the ſame, making the needle always paſs through the leather between the oiled ſilk.

W. W. CAPPER.

Query.—Would it not be an improvement if a ſtrip of leather were nailed over the valves, ſo as not to allow them to turn quite back?—T. B.

XXI. *Recapitulation with ſome additional miſcellaneous facts.*

It appears already that the principles, which had been deduced from the modern experiments on reſpiration, are too narrow to explain the effects of differently modified atmoſpheres on the animals, by which they are reſpired. This is nothing diſcouraging; for the more various the powers of elaſtic fluids, the greater, we may hope, will be the reſources of pneumatic medicine.—The two inſtances in which greater toughneſs of the fleſh and tendency in the blood to coagulate were obſerved after immerſion in oxygene air, afforded the pleaſing proſpect of a phyſiological diſcovery; but in an enquiry, where unobſerved

 powers

powers may ſo eaſily intervene, I have laid it down to myſelf as a rule of prudence, not to admit any cauſe, unleſs the effect ſhould diſtinctly appear upon four or five repetitions of an experiment with or without variation of acceſſory circumſtances. Two other pairs of rabbits were therefore procured; and one individual of each pair was oxygenated; its fellow being left without preparation, and then both were killed by blows on the back of the head. The difference of coagulation in the blood was the ſame as in the former experiments; but after boiling I could not ſatisfy myſelf that there was any difference in the ſtate of the muſcular fibres. One of theſe rabbits remained in the oxygene air 20, and the other 25 minutes; the others had only remained 15 minutes. Theſe rabbits ſeemed as thirſty as the former; one drank eleven times.

Of two white pigeons, ſeemingly of the ſame age, one was kept in a veſſel of oxygene, mixed with a third part of atmoſpheric air for 25 minutes; birds conſume air very faſt; and at the end of this time, a candle was immediately and repeatedly extinguiſhed on immerſion in the veſſel, which was the ſame as that in which the cats had been placed; the pigeon ſhewed no other ſign of diſtreſs than a little quickneſs of breathing; which took place ſoon after its introduction. The power to ſtand erect in ſuch an atmoſphere, depended probably on the oxygene it had previouſly inſpired, as in the experiments on drowning. The pigeon was ſtrangled on being taken out of the veſſel and quickly opened; the blood coagulated inſtantly after effuſion, and in ſome of the veins it was already coagulated. The heart was hard and

inirritable;

inirritable; the cavity of the ventricles was closed; the auricles contained a little coagulated blood; the lungs were florid and appeared inflamed.

The other pigeon was put into a mixture of more than one third atmospheric, with less than two thirds of hydrocarbonate, air. It died in less than half a minute; its speedy death probably arose from the same cause as the rapid consumption of oxygene in the former experiment. No signs of recovery appeared while the feathers were hastily stripped from the belly and breast; the liver as before appeared much more ruddy than in the former pigeon; this undoubtedly depends on the greater proportion of venous blood in the liver than in any other organ; the heart and other viscera were more ruddy in the hydrocarbonated pigeon; the lungs excepted, which were of nearly the same colour in both. The ventricles of the heart were inirritable, and contracted in the hydrocarbonated; but the right auricle was spontaneously acting. The blood was fluid and ruddy; it was some time before it coagulated. The flesh of the heart was remarkably ruddy.

These pigeons being boiled, the hydrocarbonated was universally of a light red; the colour was strongest in the legs; it was well seen in the marrow and spongy part of the bones; the cartilages looked as they sometimes do in the young subject injected: in the breast of the pigeon (which on account of the state of the air when it was taken out of the vessel, I dare not call oxygenated) a degree of redness was perceptible; but the difference was great in favour of the hydrocarbonated: this was throughout as red as a salmon in season; it was observed on occasion of the redness produced

produced by the ſame air in the muſcles of the thighs in a fowl, that one might have ham and fowl in the ſame piece. The breaſt and wings were of a tender pink.—The fleſh of the hydrocarbonated pigeon four perſons agreed in thinking more agreeably taſted.—In point of tenderneſs there was no great difference; if any exiſted, it was perhaps in favour of the latter.

The effect of hydrocarbonate on the blood and fleſh was ſo oppoſite to all expectation, that I could not be ſatisfied without repeating the experiment till all fear of an erroneous concluſion vaniſhed. Of a pair of fowls, one was put into carbonic acid air, and one into hydrocarbonate; in the former, the appearances were the ſame as in drowned and ſtrangled animals, only the liver appeared a ſhade paler. In the hydrocarbonated, the phænomena were as uſual. It was thought by ſeveral perſons who taſted theſe fowls after they were boiled, that the fleſh of the hydrocarbonated was leſs conſiſtent; it was ſaid to approach towards the ſoftneſs of dreſſed liver.—Of two equal rabbits, one was immerſed in ſuch a mixture of atmoſpheric and hydrocarbonate airs as did not deſtroy life in 15 minutes; it was then taken out in a ſtate of great debility; both were killed in the uſual manner. The blood, liver, and other viſcera of the hydroc. rabbit exhibited the accuſtomed phænomena. The fleſh was of a light pink colour when boiled, the marrow of a fine red.

The power therefore of hydrocarbonate air to redden the blood and fleſh of animals, made to reſpire it, either pure or diluted, admits of no doubt. I have attempted to determine the circumſtances of its operation, by applying it directly to the blood. In two phials containing one hydrocarbonate, and the other

carbonic

corbonic acid air, two funnels were cemented, the necks of which were closed by a wooden stopple.— Blood was received into each funnel as it flowed from a man's vein; when the funnel was full, the stopple was withdrawn and the blood descended into the phials, while the air issued through another small perforation in the cork, which could be closed at pleasure. When the greater part of the blood had descended into the phials, they were stopped, so as on trial to prove air tight. The blood in the phial containing carbonic acid air, acquired no florid colour on its surface; the edges of the coagulum, as they lay against the phial, appeared brighter; but this, upon careful examination, appeared to be owing to their thinness. The hydrocarbonate evidently brightened the upper part of the coagulum to as great a depth as it is usually brightened by oxygene or atmospheric air. The colour was not quite so florid, and yet not a great deal less so. There is, however, a difference in the shade, which to be clearly conceived, requires to be seen.

Three equal and similar vessels were filled, two with hydrocarbonate and one with atmospheric air. Blood was received from the vein of a horse into a funnel, and then suffered to run into these phials. That containing atmospheric air, and one of the others, were immediately stopped and shaken. The blood was observed to acquire a brighter colour throughout; in both cases a head of foam rested upon the surface; and this appeared nearly of the same colour in both; the head was rather brighter than the close and condensed mass, on account of the light transmitted thro' bubbles of air detained in the blood.

Four phials were filled; one with oxygene, one

with hydrocarbonate, one with atmofpheric, and one with hydrogene air from zinc, diffolved in muriatic acid. Blood was received into a funnel from the vein of a horfe, and then fuffered to run into each of thefe phials. The blood in the oxygene and atmofpheric airs was equally brightened and to an equal depth; in both the other phials, the furface of the blood was brightened; but more in the hydrocarbonate and to a greater depth. In this the florid colour (which was inferior to that produced by the oxygene and atmofpheric airs) reached three lines in depth; and the reft of the coagulum was lefs dark than the reft of the coagulum in the hydrogene; in which the brightened part did not defcend more than a line.

The change of colour on the furface of the hydrogene (which does not I think agree with the obfervations of fome philofophers, who have expofed blood to different airs, but without ftating the circumftances of the experiment, particularly the age of the blood) induced me to immerfe a third pigeon, nearly the fellow of the two former, in hydrogene from zinc, diffolving in muriatic acid. The liver appeared rather paler than in pigeons killed in the common manner; but it had nothing like the brightnefs of the liver in animals deftroyed in hydrocarbonate; the veins were of their ufual dark colour, and fo was the blood. The heart was not ruddy, but it was flaccid; and in this refpect formed a remarkable contraft with the hearts of the two other pigeons. The right auricle was working; the ventricles not irritable. The boiled flefh did not fenfibly differ from the flefh of pigeons that have inhaled atmofpheric air, except, perhaps, in a very flight rednefs of part of the breaft.

The

The muſcles of the legs, which when they are brown in birds, ſhew the colouring power of hdc. a. ſo diſtinctly, were not at all tinged; nor did the cartilages of the joints look as if beautifully injected; but were pale, as in common caſes. Hydrogen, as far as this ſingle experiment warrants the concluſion, has no power to make the fleſh of animals tender: and in two or three days the brightened ſurface of the blood expoſed to it grew dark again, and the whole clot (½ an inch thick) ſeemed blacker.

To diſcover the effect of hydrocarbonate on the blood at different periods after venæſection, a portion of the dark coagulum of a horſe's blood two days old, was put into a quart of this air, and another part into a quart of atmoſpheric air. The veſſels were equal and ſimilar. A florid coat ſoon appeared on the blood in the atmoſpheric air; but no change took place upon the blood in the hydrocarbonate, though it was watched ſeveral days. Human blood was put to the ſame trial nearly as ſoon as it coagulated, which was within a quarter of an hour after it was drawn: no change in the bottle of hydc. a.—The clotted part of a horſe's blood was tried a day after it was drawn; a comparative experiment was made with both oxygene and atmoſpheric air: theſe laſt brightened the ſurface as uſual. The hydrocarbonate produced this effect in a very ſlight degree: upon the credit of theſe and ſome other ſimilar experiments, it may be affirmed that hydrocarbonate air has little power to render blood florid, except it be fluid; but this I think depends on the coheſion it acquires, and not on the life it loſes. There is ſome danger of miſtake from haſty obſervations on the thin edges; I

depended

depended principallly upon the appearance of the surface, where the mass was such as to produce perfect opacity. Mr. Charles Gimbernat remarked in various instances that more serum separated from the blood in hydroc. a. and that the coagulum formed a much smaller cylinder in the phials containing this air, than in those containing oxygene, atmospheric, hydrogene, or carbonic acid air.

When phials containing hydrocarbonate and blood were opened under water, there was no sign of diminution in the bulk of the air.

Blood being received into a funnel from the arteries of a horse, and transmitted into hydrocarb. the phial was stopped air-tight and shaken; the colour did not become deeper or darker. Venous blood being at the same time treated in the same manner, acquired a colour little less bright than the arterial.

Mr. Watt informs me that he has lately observed pieces of raw flesh keep sweet longer after immersion in hydrocarbonate air.

These facts will suggest a variety of reflections and many new experiments. They seem to disclose the principle on which hydrocarbonate acts in changing the colour of the venous blood. Its effect, so far as colour is concerned, is not destroyed in passing through the small arteries; hence the alteration is seen in the veins, and by consequence in the solids, particularly the liver. This colouring principle (supposing something to be imparted to the blood) differs therefore in its affinity to the animal fibre from oxygene, if oxygene be distributed by the arteries.—Hydrocarbonate

does not, as I at first suspected, become explosive after exposure to animal ss. Hydrogen, on the contrary, becomes unexplosive. Whether hydrocarbonate is decompounded or partly absorbed, remains to be determined by nicer instruments than I have it in my power to employ at present.

A florid complexion, may then, it seems from these experiments, as far as it is connected with the mere substance of the blood, depend equally on arterial blood highly oxygenated, or venous blood brightened, as by the application of hydrocarbonate. It may at present be difficult to distinguish the two cases. The blood is frequently florid, as it flows from a vein. But in many of these instances, arterial blood only escapes the change it commonly undergoes in its progress through the small blood-vessels. Thus when Mr. Hunter says, "I bled a lady whose blood at first "was of a dark colour; but she fainted, and while "she continued in the fit, the colour of the blood "that came from the vein was of a fine scarlet;" we may suppose the action of the small arteries to have been suspended, and the oxygene not to have been communicated to the solids; the same when an animal is bleeding to death. Mr. Hewson observes, that the blood from faint animals is brighter and coagulates more speedily; which may depend on its containing more oxygene. Yet if the rapid coagulation in my experiments was occasioned by oxygene actually present in the venous blood, it was in such quantity as not to brighten the colour.

It might be thought that the oxygene of the blood, forming carbonic acid with hydrocarbonate gives redness;

neſs; but the application of carbonic acid, both to the blood and to the lungs, diſcountenances this idea. Theſe experiments ſhould be further proſecuted with arterial blood. Meanwhile as it is certain that the blood and the ſolids may acquire a bright red colour, though not the ſame ſhade preciſely, from cauſes totally diſtinct from the preſence of oxygene, my conjectures concerning the condition of the ſyſtem in ſome caſes of conſumption loſe their ſupport.—But although I cannot now believe that the permanent redneſs which I am ſo much accuſtomed to ſee in the fauces in ſome conſumptive patients, and other analagous appearances, indicate hyperoxygenation, I ſtill think it probable that exceſs of this principle does actually occaſion diſeaſe. But beſides colour, I ſhould require ſome of the ſymptoms occaſioned by the reſpiration of too much oxygene to appear, before I admitted this cauſe. Dr. Garnet has, I think, fixed upon inſtances of this nature; and perhaps the frequent pleuriſies in the Caſtiles partly depend on the dryneſs of the atmoſphere; a quality which, if it ariſe from the want of water, and not its combination, implies the preſence of more oxygene in a given bulk of air.

The cautions and ſuggeſtions reſpecting the reſpiration of ox. air, which I had deduced from perſonal experience, ſeem confirmed by circumſtances in ſeveral of the foregoing reports. Elevation of ſpirits, and power of reſiſting cold, have oftener than once followed its uſe; it has alſo been found to heighten the complexion. Mr. Barr's patient, and Mr. Atwood, furniſh ſtriking proof of its power to improve ſome debilitated conſtitutions. Both communications afford inſtruction reſpecting the doſe, which requires much

much vigilance. In the former of these cases it was necessary to lessen the quantity; and in Mr. Atwood's interesting journal, though we have unfortunately no precise information on this head, there are particulars that seem to shew that he proceeded to the utmost verge of prudence. These examples will encourage further trial in different sorts and stages of debility. This elastic fluid deserves to be opposed to the approach and to the infirmities of old age, especially where the extremities are habitually cold. A quart inhaled every day, for a few weeks, and repeated from time to time, as the patient's feelings shall direct, bids fair to contribute to the comfort and prolongation of life. Its employment in chlorosis, will, I trust, be continued with success. I am authorized to say, that a remarkable cure of hysteria will be related in the 2d vol. of Mr. Townshend's *Guide to Health*. Its power in the last stage of malignant and nervous fevers ought to be ascertained in the course of another year. Nor is there any thing more urgent than to try it in typhoid or unfluent small-pox: which disorder has raged dreadfully in Bristol this winter, and proved fatal in spite of wine, the yellow bark and opium. I have been prevented by prejudice from ascertaining the effect of oxygene.

In palsy, fact does not yet appear to coincide, as could be wished with expectation. We may very safely put a paralytic patient on a course of oxygene air; but we should begin with very small doses, and be alive to suspicion. To prevent groundless alarm, I must add, that I have no other reason to give this warning, than what is already before the reader, (see p. 71, 72.)—In paralysis of the absorbents occasioning anasarca

anafarca of the lower extremities and of the lungs, I have been informed that confiderable temporary relief has been afforded. One cafe has fallen under my own care—it is as follows: — R. G. about 60 years of age, after living freely, had dropfical fymptoms. He underwent a long courfe of violent cathartics, and afterwards came to Briftol Hotwells. The paralytic appearances were fo ftriking, that I declared to his friends, in the moft pofitive terms, that I apprehended he would in no long time die fuddenly. The digitalis (which I have never feen to fail in cafes of this kind) procured a difcharge of the water. It repeatedly collected, and was repeatedly evacuated by the digitalis, and once or twice by fquill and the *pulvis ari comp.* The medicines had now no fooner ceafed to operate, than a relapfe followed, and threatenings of apoplexy were feveral times obferved. At this period oxygene air, mixed with twice its bulk of atmofperic, was adminiftered for the fpace of one minute, four times a day. During the whole courfe of his difeafe, the patient had that tendency to ficknefs and vomiting, which the long abufe of fermented liquors produces. The modified air was found by the patient to relieve thefe fymptoms; and by refpiring it, he faid he could prevent and remove naufea. From his obfervations I think ox. air more likely than any thing elfe to carry off violent affection of the ftomach, arifing from an overdofe of digitalis. The difficulty of breathing was always relieved by his mixed air, though only for a fhort time. In lefs than a month, he by degrees came to refpire for 15 minutes in a day. The fwellings, however, increafed, and there were evident figns of effufion in the thorax; fo that the oxygene did not appear to render the abforbents more irritable. One day,

after

after walking for half an hour (which was an unuſual exertion) the patient ſuddenly expired on entering his apartment.

The idea of adminiſtering oxygene air to perſons affected with ſea ſcurvy, is extremely obvious. But the frequent inſtances of ſudden death, when ſcorbutic patients are brought into the open air, deſerves ſerious attention. The principal doubt ſeems to be, whether it is muſcular exertion, ſome ſenſation, or the free atmoſphere, that proves fatal. After reading Dr. Trotter's late candid publication, I applied to the author for a ſolution of this difficulty; his inſtructive anſwer follows; and I own, that it appears to me to amount to a prohibition of the practice.

Spithead, March 13th, 1795.

SIR,

In anſwer to your query, whether the perſons who died ſuddenly in ſcurvy on expoſure to the air, had uſed much muſcular exertion, I beg leave to inform you, that I do not think any preceding exerciſe of muſcular motion had any ſhare in producing this effect, The firſt caſe of the kind I ever ſaw, was from opening a port to windward; the air ruſhed in with conſiſiderable force, I was ſtanding by the man, he had converſed with me with apparent eaſe, and ſeemed to feel no pain when he expired. I have ſeen others drop down immediately on coming above the hatchway, although they could walk below with tolerable agility: Some have died after being carried above, in a horizontal poſture, both legs being ſo hardened and contracted

contracted that they could not walk; and others have been ſaved by going immediately below. Might not all this be owing to the diminiſhed temperature of the air, independent of its chemical qualities? Scorbutic patients bear cold very ill, but ſudden death happens often under ſimilar circumſtances in hot tropical countries, and I own this explanation not ſatisfactory.

I am afraid opportunities of trying the diluted oxygene in a ſhip, cannot be eaſily commanded. There is no medical board in the navy to countenance improvement. There is alſo ſo much room left for reformation in other reſpects for the benefit of health, that ſince I had the honor of attending the channel fleet, our great commander has been conſtantly ordering ſome beneficial regulations. From ſuch active benevolence and authority, I have ſtill much hope. Wiſhing you health to continue you valuable purſuits,

I am, Sir, &c.

T. TROTTER.

Having lately received information of a very ingenious application of air to ſurgery, I ſhall inſert it here as the effect appears to depend on a reſidue of oxygene.—" Mr Gimbernat, Surgeon, at Madrid, reflecting upon the action of atmoſpheric air, admitted into the joints, was led to ſuppoſe that its introduction into the ſcrotum would excite an inflammation of the adheſive kind in the parts that require to be united for the radical cure of the hydrocele; in which caſe this might prove the eaſieſt and moſt efficacious method of treating the diſeaſe.

Mr.

Mr. G. therefore paſſed through the ſcrotum of a patient, afflicted with hydrocele, a trocar much longer and thinner than that commonly employed in the operation for aſcites; taking great care to leave the teſticle as much as poſſible behind, and at a diſtance from the inſtrument. He then withdrew the perforator, leaving the canula; which being pierced with ſmall holes in its whole circumference, allowed an iſſue of the water contained in the ſcrotum. When this was completely diſcharged, the operator ſtopped one of the orifices of the canula, and through the other blew into the ſcrotum a quantity of air from the lungs. This operation was repeated once or twice a day till the ſcrotum was reduced to almoſt its natural ſize; for which purpoſe the canula was properly ſecured by a bandage in the ſcrotum.

When the parts had acquired ſo much adheſion as to contract round the canula, the inſtrument was removed, and the cavity it left was ſoon filled with new ſubſtance.

Mr. G. contrived this method 15 years ago; and he has uniformly ſucceeded in a very conſiderable number of caſes of hydrocele. A fortnight or thre weeks has generally been ſufficient for a radical and complete cure. The patient is never confined to his bed, but can walk about his room without inconvenience. Mr. Gimbernat thinks the great ſucceſs of his method is owing to the ſmall degree of inflammation excited by the expired air."

Mr. Townſhend, in the 1ſt vol. of his GUIDE relates three caſes in which the reſpiration of oxygene appeared highly beneficial. One is a caſe of hypochondriaſis,

chondriafis, another of afthma, and a third of fuch diforder of the ftomach, that eating "almoft conftantly produced vomiting;" in this cafe the patient "continued free from ficknefs as often as the oxygene "air in a diluted form was adminiftered;" — (p. 277, 292, 398).

I had formerly been led to infer that "an atmo-"fphere with a diminifhed proportion of oxygene, "would be in fome cafes a better foporific than any "we at prefent poffefs." I have fince received confirmation of this opinion. A perfon in confumption, who for months had taken opium at night, flept perfectly well without opium when he came to refpire hydrogene. His fleep he remarked to be more profound than ufual. The air of his room being largely mixed with hydrogene, his fervant, a very bad fleeper, declared that he "did not know what was come to "him, he flept fo found." This man neceffarily infpired much hydrogene from attendance on his mafter. A phyfician has favoured me with the following memorandum of an obfervation on himfelf; which poffibly may be referred to the fame caufe. He could not fix upon any other. "For feveral years I "have paffed reftlefs nights, and have feldom flept "longer than from half an hour to an hour at a time; "but on the night of the general illumination for the "victory of the firft of June, I enjoyed a found and "almoft uninterrupted fleep; this I impute to my "having fat between four and five hours in a room "with about twenty candles burning, immediately "before I went to bed, and to having had the fame "number burning as long in my bed-chamber; al-"though the weather was warm, I felt a glow of

"heat

"heat on entering the chamber, with a ſtrong ſmell of "the candles; and as heat generally prevents my reſt, "I was pleaſantly diſappointed by a more comfortable "ſleep than I had had for fourteen years before. I "have experienced the ſame want of good and con- "tinued ſleep ſince." Whether a diminiſhed atmo- ſphere produces a tendency to ſleep or not, diluted hydrocarbonate (of which the properties can ſcarce be ſuppoſed to depend on privation of oxygene) undoubt- edly poſſeſſes this property. My experience amply confirms the preceding reports. In two conſumptive patients, I am able to induce ſleep almoſt at pleaſure by this air. In a great majority of ſuch caſes, it is well known that the nights are exceedingly diſturbed in ſpite of opium, freely adminiſtered. The ſoporific virtue of hydrocarbonate, ſeems however by no means to be confined to conſumption.

I introduce here the following letter reſpecting conſumption, from Mr. Darling, Pref. of the R.M. Soc. at Edinburgh. It did not come in time for inſertion in its proper place. Mr. D. does not ſeem to have uſed hydrocarbonate air.

Edinburgh, Feb. 24th, 1795.

SIR,

The caſe to which I alluded in my letter was ſimply this.—A young lady labouring under every ſymptom of confirmed phthiſis pulmonalis, and daily ſinking under the diſeaſe, happened to be reſiding at the houſe of an eminent tar merchant to whom ſhe was related. No remedy ſeeming in the leaſt degree efficacious, it was propoſed that ſhe ſhould walk in one of his ware- houſes, where a large quantity of Plantation tar was

usually kept. The first time she was introduced into it was on a Monday morning, when it was imagined, in consequence of the warehouse having been shut up since the Saturday afternoon, the air would be the most fully impregnated with effluvia. She walked a considerable time through the different ranges of barrels, and bore the experiment very well. This practice was persisted in several mornings with advantage: and finding the cough and other symptoms gradually decrease, she persevered till she was restored to perfect health.

Since I last wrote to you I have finished the account which I was then drawing up, of experiments with factitious airs in the cure of consumption, and read it to the medical society of this place. I have had about ten opportunities of trying their effects, but have been considerably disappointed, as I was not able to effect a permanent cure of any of them; but it must be observed, that in all of them the most distressing symptoms were evidently relieved — as the cough, night-sweats, diarrhœa, want of rest, fever, &c. and in one of them the hectic fever totally disappeared, and at present there only remains a cough, which is not very troublesome: nevertheless, I am much afraid that this immensely severe season may possibly bring on a relapse, but this must be guarded against as much as possible. My want of complete success I attribute in some measure to the imperfect state in which my apparatus was; or it may possibly have arisen from the remedies not having been applied with sufficient vigour, or perhaps from the disease in all the cases having made too great a progress before the administration of a reduced atmosphere.

W. C. DARLING.

I have

I have not displaced Mr. Darling's letter in the present edition. The same cause, viz. its arrival during the impression, obliges me to introduce the following interesting information from Dr. Pearson in this place.

Birmingham, Jan. 28th, 1796.

DEAR SIR,

As it may be twelve months before I publish *all* the facts which have come under my cognizance in favor of the use of æther vapor, either alone or in combination with other substances, in phthisical cases; I wish in the mean time to make known to the medical world, an instance or two in confirmation of the good effects of this remedy, that it may get into other hands as soon as possible. I therefore send you the following cases and remarks, of which you will dispose in whatever way you chuse.

I am, with great regard,

Your's, &c.

W. PEARSON.

To Dr. Beddoes.

Elizabeth Vyse, aged 27, having been seized at the end of the autumn with cough, fever, and spitting of blood, applied to the hospital for relief, and came under my care last October. She informed me she had been subject to a cough for three winters. She had a quick and small pulse, flushed cheeks, dyspnœa, pain of the side, constant cough, attended with copious expectoration, and night-sweats. She was very feeble and

 much

much emaciated. The hæmoptoe was ſoon removed by the medicines commonly preſcribed in ſuch caſes; but the other ſymptoms continued. I therefore ordered her, on the 12th of November, to breathe the vapour of vitriolic æther, impregnated with extract of cicuta, two or three times a day. On the 19th, when I ſaw her again, ſhe informed me that ſhe had obtained great relief from the æther-vapour, having much leſs tightneſs acroſs the cheſt, and leſs pain of the ſide. She ſaid ſhe was ſomewhat giddy after every inhalation. December 3d, leſs fever, leſs cough, and conſiderably better in every reſpect. Has found more benefit, (to uſe her own words) from the æther application than from any thing elſe. December 10th, Cough and other complaints ſo ſlight, that ſhe ſays ſhe does not require any more medicines.

N. B. During the uſe of the æther-vapour, ſhe took a decoction of the Peruvian bark and ſarſaparilla, and pills compoſed of extract of cicuta and rhubarb.

In another caſe (a private patient) of a boy about fifteen years old, of a conſumptive habit, a catarrh attended with fever of the hectic type, was removed in leſs than three weeks, by the application of the ætherial tincture of cicuta, in the form of vapour, to the internal ſurface of the lungs.

I have juſt met with Mr. Davidſon's book on the pulmonary ſyſtem. As I have not yet read a third part of it, I am not qualified to ſay any thing reſpecting the doctrine and practice therein laid down. I have only dipped into that part which treats of the

uſe

uſe of the cicuta in phthiſical caſes. I perceive he has fallen upon the idea of applying this narcotic to the internal ſurface of the lungs. To which of the two, him or myſelf, the thought firſt occurred, is a matter not worth diſpute. I can only ſay that I have it recorded upon the books of our hoſpital, that I have been in the habit of preſcribing to conſumptive patients æther impregnated with cicuta (along with the extract made into pills), for as much as a twelve month paſt. Perhaps Mr. Davidſon may have preſcribed the vapour from decoctions of the ſame herb, as long. But, until now, I have been as entire a ſtranger to his practice as he no doubt has been to mine. It is of little conſequence who firſt thought of the remedy; the point of moſt moment is, that both agree in the report of its good effects.

What induced me to preſcribe it in this way, was the advantages which have frequently been obtained from it in ſcrophulous ulcers, when applied topically as well as internally. I do not, however, aſcribe all, or even the greater part, of the good effects which I have experienced from this method to the cicuta; much, indeed the largeſt ſhare of the benefit that has flowed from it, I attribute to the medium by which the narcotic particles of the cicuta were conveyed to the lungs; I mean the æther-vapour, which, when breathed alone, affords, in many pulmonic caſes, very conſiderable relief. I wiſh Mr. Davidſon, or any other gentleman, who is earneſt in the buſineſs, would compare the effects of cicuta, when applied by means of the vapour of water, with thoſe which it produces when applied along with the vapour of æther. Of the former

former vehicle, I can only ſay that I think it objectionable on account of the heat which attends it. I do not forget Mr. Mudge's remedy for a catarrh; but the ſtate of the lungs in catarrh and conſumption muſt be allowed to be different. Moreover, I do not believe that water, even with the aſſiſtance of heat, can take up ſo many of the medicinal particles of the cicuta, as æther, which, beſides, poſſeſſes (as I have before hinted) ſuch peculiar properties, as are ſuited to induce a ſalutary change in the action of the veſſels of the diſeaſed part, properties which are altogether wanting in the ſteam from water.

P. S. In my laſt letter I forgot to mention that frequent agitation is necſſary to promote the ſolution of the extract of cicuta in æther. Another way of expediting the ſolution is to triturate the extract (previouſly to its mixture with the æther) with a little ſalt of tartar or teſtaceous powder, and as much water as will give it the conſiſtence of a ſyrup. Inſtead of the extract, I now employ the powder of the dried leaves, from which I obtain a much more ſaturated tincture.

Æther extracts the aſtringent principle from vegetable ſubſtances very abundantly. The tincture made with powdered galls is a very ſtrong preparation. The vapour from æther thus ſaturated with the aſtringent principle, promiſes to be ſerviceable in ſome kinds and ſtages of phthiſis, in which the ſtate of the mucous glands of the bronchial tubes is analagous to that of the ſecreting veſſels on the internal ſurfaces of the urethra and vagina, when theſe parts are affected with gleet and fluor albus. In theſe laſt the topical application

application of aſtringents is known to be of uſe; and as there appears to be the ſame atonic condition of the ſecreting veſſels on the internal ſurface of the lungs, in what is termed pituitous conſumption, we have reaſon to believe that the ſame application will produce, in this caſe alſo, the like good effects.

In aſthma it is extraordinary that oxygene, hydrogene, and hydrocarbonate, ſhould have afforded relief. Dr. Carmichael has this reflection in one of his letters. It aroſe from the caſe of an aſthmatic patient, whom one of the phyſicians to the Birmingham Diſpenſary, has lately much relieved by oxygene.—Dr. Ferriar (p. 80.) and Mr. Townſhend, confirm the fact. It may be ſaid that oxygene air prevents the paroxyſm by exhauſting excitability, as ſpirituous gargles cure an incipient inflammation of the throat; and that unreſpirable airs withhold ſtimulus; but this ſeems by no means probable of hydrocarbonate; and the truth is that we have not yet experience to eſtabliſh thoſe diſtinctions, which are requiſite to the certain direction of the pneumatic practice.

In the inflammatory ſtage of catarrh, and all the gradations of diſeaſe which connect a common cold with pleuriſy, I hope the exhibition of a lowered atmoſphere will prove an effectual cure. In theſe caſes I am at preſent inclined to prefer hydrogene or azotic air, becauſe they can be ſo freely and frequently adminiſtered. In my letter to Dr. Darwin, I have deſcribed the effect of atmoſpheric lowered with one-eighth of hydrogene air, and reſpired for a quarter of an hour, in an inflammation of the cheſt. The acute pain entirely ſubſided while the patient was breathing this mixture,

and

and the febrile ſymptoms diſappeared.—I have been eye witneſs of another fact of the ſame kind ſince. See Conſid. part III. p. 91. — Mr. Townſhend (p. 103) has a ſimilar example. " Mrs. Tovey, of Charles-" Street, Tottenham - Court - Road, having loſt one " child" by the croup " brought her only remain-" ing boy to Dr. Thornton for his advice. He " immediately made the child inhale azotic air with a " proportion of common air; and the father and mo-" ther were ſurprized when they obſerved that the " hands which were before *parching hot*, now felt *cold* " to the touch; the pulſe was rendered twenty beats " leſs in a minute; the child no longer coughed as " through a brazen trumpet, the fever ſeemed ſmo-" thered, and the formation of the fatal membrane " was prevented."— If a lowered atmoſphere proves as ſervicable in inflammatory catarrh as the analogy of theſe caſes, reaſonable conjecture and a few direct trials ſeem to promiſe, an apparatus for factitious airs will ſoon come to be conſidered as a neceſſary part of houſhold furniture.

Different factitious airs enable us to change the conſtitution of the fluids and ſolids. By their operation on the extenſive ſurface of the lungs, they muſt alſo produce motions by aſſociation in diſtant parts of the ſyſtem. On theſe principles (if we had no immediate experience) they might be concluded capable of great effects on the chemical and mechanical agency of the animal organization. I dare not enter fully into the contemplation of their powers; but there are two or three points on which it may be uſeful to touch.

Doubts have been expreſſed whether the uſe of a modified atmoſphere and eſpecially, of unreſpirable airs, could have any other than a momentary effect. This difficulty, a man who can ſee but a little way before him, will perceive. It has been cleared up by expeperiment; and I need not heſitate to affirm that the occaſional reſpiration of modified air has a durable effect. But it is neverthele ſs true, that this important ſubject can never be ſifted to the bottom, till we have the command of rooms filled with modified air. — Uſeful as diluted hydrocarbonate has proved, no man can ſay that it would not be more uſeful, if more diluted and reſpired with greater conſtancy. The ſame doubt extends to other airs.

It has been apprehended that the fine particles of mangane ſe, ſuſpended in oxygene, might injure the lungs, as in ſtone-cutters. But there is no analogy in the caſes; engine-men, caſters in braſs, and numerous other artiſans, reſpire fine powder without detriment; and experience with the air itſelf diſcountenances apprehenſion. For we have now a number of inſtances in which oxygene from mangane ſe was breathed for many weeks; and no ſuch inconvenience has been felt.

Pulmonary tubercles are regarded by ſome as beyond the power of factitious airs to remove.* Tubercles however do not appear inconſiſtent with tolerable enjoyment of life; and there are many inſtances in books

*This opinion, however muſt be retracted if the following curious information ſhould prove juſt.

Extracts of letters from Dr. JENNER.

" I took the liberty, during our ſhort interview, of offering an opinion reſpecting the origin (in ſome inſtances at leaſt) of tubercles in

books of medicine and surgery, of the removal of bodies equally formidable. By facts related in Dr. Ewart's pamphlet on cancer, and in Dr. J. Johnstone's letter, as well as by what I have myself seen, I am persuaded that the lymphatics were excited into vigorous action by carbonic acid air. In Mrs. A.'s case the surface of the ulcer became dry; and in that of Alford, "when "the gas was most frequently renewed, the discharge "was the most diminished." In an instance of cancer, not yet published, I am well informed that the swoln and

in the lungs. A few days ago, I saw at a butcher's shop the lungs of a young heifer, which appeared to be diseased with tubercles. On cutting into some of these tumours, a *family* of hydatids immediately appeared. —— Some of these tubercles, though similar in external appearance to those containing hydatids, had within them a brown fibrous kind of substance, which to the feel was a little gritty. In this case it is pretty clear, that the tubercle was a *mansion built* by the *hydatid*, and I am sorry to say this destructive little animal appeared to be unassailable within its walls, as I could not perceive any branches of the trachea opening within them: but this may not be the case in the early stages of its structure. May not the infant tubercle described by Stark be an hydatid?

"The fact of the hydatids forming tubercles in the cow's lungs was very clearly ascertained. I made a preparation of the parts. — Pray make what extracts you please from my letter, if you think I have expressed myself intelligibly. Many of Dr. Stark's observations on tubercles tend to strengthen my idea of their origin, particularly the following. "No blood vessels are to be seen upon them, even "when examined by a microscope, after injecting the lungs from the "pulmonary artery and vein." (Medical Communications I. page 390.) If, as I suppose, they are extraneous bodies, they are of course no more capable of receiving injections, than worms that adhere to the intestines. Stark describes the tubercle, as being hard and compact before it arrives to any considerable size. — If I recollect right, that species of hydatid, which pervades the cellular membrane of the hog is solid or nearly so. It is singular enough that hydatids should be more common among those animals which live in a state of nature than among the human species. —— Hares, rabbits, cows, and hogs are infected with them perpetually; — the hog, indeed, can scarcely be said to be in a state of nature here. Among quadrupeds, I do not see that the constitution is affected by them; the animals thrive and grow fat in an equal degree with those which are free from them, even though they occasion suppurations among the viscera. — In the liver of the cow that produced the hydatids from the lungs, were several distinct bags of well formed pus, yet the animal was very fat and had no marks of disease before it was slaughtered.

E. JENNER.

Berkeley, Jan. 29, 1796.

and indurated glands have been reduced by carbonic acid air to their natural ſize and ſoftneſs. Hence I conclude that the ſalutary operation of this air in part conſiſts in its action on the lymphatic ſyſtem; and it can hardly be doubted that there is a degree of abſorbent operation equal to the removal of tubercles.— Whether hydrocarbonate poſſeſſes this property, the trials now making on cancers are likely to decide.— I wiſh the reſpiration of unreſpirable airs were tried in encyſted dropſy; in one caſe of which I fully tried oxygene without benefit.

If a ſpecies of opium, capable of lulling the excruciating pain of cancer for weeks or months, had been diſcovered, it would doubtleſs be received with avidity by the members of the medical profeſſion, and with benedictions by the diſeaſed. But becauſe it is uncertain whether a compleat and permanent cure can be effected by the application of air, this treatment is not only neglected, but reſiſted; yet no pretence is made to ſubſtitute any thing more efficacious: no natural cure or mitigation is looked for; no injury is dreaded from the new method; and the authority on which it is ſaid to afford at leaſt long-continued eaſe, is neither queſtioned nor queſtionable. For ſuch conduct, language wants a term ſufficiently opprobious, for it implies whatever is contemptible and odious in ſloth, in ignorance, in narrowneſs of mind and hardneſs of heart. Here I invite my readers to reflect and to hold their opinions at all times ready for delivery; for although this great crime againſt humanity is not puniſhable by law, it may be prevented by the cenſure of an enlightened public.

PART II.

DESCRIPTION

OF A

PNEUMATIC APPARATUS,

WITH

DIRECTIONS

FOR PROCURING

THE FACTITIOUS AIRS.

BY JAMES WATT, ENGINEER.

MR. WATT's advertiſement to an edition of his Deſcription, publiſhed ſeparately.

SINCE the firſt publication of this Deſcription, experience has ſuggeſted ſome improvements in the mode of conſtructing and of uſing the Apparatus, which in the preſent ſtate of Pneumatic Medicine, it would be improper to delay communicating to the Public. Every hint, however trifling in itſelf, now attention is awake, may lead to uſeful diſcoveries.

The Author has alſo availed himſelf of this opportunity to methodize and elucidate his deſcription in a manner which the former haſty publication would not admit of. One of the original plates has been rejected, and another, repreſenting the improved uſe of the Fire-Tubes, has been inſerted in its place. Conceiving the Apparatus may fal into the hands of perſons who have not been accuſtomed to chemical

chemical experiments, clearness has been aimed at, even at the hazard of prolixity. Though the Author wishes to shun the imputation of neologism, yet to avoid circumlocutions, he has found himself obliged to form some new words, such as the Martial Zincic, *and* Carbonic Inflammable Airs, *which latter he has also called* Hydro Carbonate.—*He has indifferently made use of the terms of the old and new Chemical Nomenclature, wishing merely to be understood, and not intending to enter into discussions upon theories in a treatise, the objects of which are facts.*

The purchasers of the first edition, it is hoped, will not deem any apology necessary. It contained all the Author then *thought worthy the notice of the Public, as this contains all he* now *deems essential to the right use of the Apparatus, which probably, from the progressive advancement of Pneumatic Chemistry, will soon receive great additions.*

At the time of the former publication, few professional men having considered the subject, the Author ventured to give his opinion in some letters to Dr. Beddoes, on the airs which he thought the most likely to be of use in diseases of the lungs, and he esteemed it a duty to relate the few physiological observations he had made in the course of his chemical experiments to produce the airs; but he now thinks it would be improper to swell his pamphlet by a republication of those letters, as the subject is taken up by persons who are better able to judge in such matters. For what has yet been done in the application of the air to medicinal purposes, the Reader is referred to the publications of Dr. Beddoes and Dr. Ewart upon this subject.

Several

Several of the apparatus are now in the hands of able practitioners, and the Public at large is apprized of the importance of the practice, and will no doubt give it a fair trial. It is honorable to the present improved state of science, and it is honorable to the faculty in particular, that the application of Pneumatic Chemistry to medicine far from meeting with that persecution which has generally in every age followed new opinions, has obtained the well wishes and liberal support even of those who have doubts of its efficacy, but who are no less desirous of having those doubts cleared up by actual experiment.

HEATHFIELD, *Jan.* 1795.

DESCRIPTION

OF A

PNEUMATIC APPARATUS.

THE apparatus may, for the facility of deſcription, be divided into four parts, the uſes of which are eſſentially different. Firſt, an ALEMBIC, or POT, A, *ſee plate* 1, *fig.* 1, or in lieu of it, a FIRE-TUBE, *a*, (*ſee plate* 1, *fig.* 3, *and plate* 3, *fig.* 1, 2, *and* 3) intended to contain the material or ſubſtance to be expoſed to the action of the heat, with a *Water-pipe* D C, adjuſted to its capital, for the purpoſe of admitting water to aſſiſt the generation or expulſion of the factitious air.—Secondly, A REFRIGERATORY G (*plate* 1, *fig.* 1) ſerving to cool and waſh the airs, which are conveyed thither by the *Conducting-pipe* F, connected with the Capital of the Alembic or Fire-tube.—Thirdly, an HYDRAULIC BELLOWS H J, to receive and meaſure the air as it comes cooled from the Refrigeratory through the *Communicating-pipe* P.—And, Fourthly, an AIR-HOLDER Y, *plate* 3, *fig.* 1 *and* 2, into which the Hydraulic Bellows diſcharge the factitious air by means of the *Transfer-pipe g*, and in which it is afterwards preſerved, and may be removed from one place to another.

In lieu of this latter veſſel, in caſes where the patient is at hand, the air may be immediately transferred from the Hydraulic Bellows through the *Diſcharging-pipe* Q, into *oiled ſilk or linen bags*, or ſuch other veſſels as ſhall be thought convenient for mixing it with the proper proportion

portion of common air, and alſo for the patient to inhale from.

1. The ALEMBIC and FIRE-TUBE. *The Alembic* A, *ſee plate* 2, *fig.* 4. is made of ſoft caſt iron, about half an inch in thickneſs, and ſix inches in diameter in its wideſt part or *bilge.* It has a Capital B, of the ſame metal, the lower part of which is made conical and ground into its mouth, ſo that the joint may be made tight with a ſmall quantity of cement. Through the middle of the upper part of the Capital paſſes the *Water-pipe* D C, which reaches to within a ſmall diſtance of the bottom of the Alembic; at the top of it is a cup D, to contain water, in the centre of which a wire E, is placed, extending within the Water-pipe to C, where it terminates in an acute cone, accurately fitted to the lower opening of the Pipe as ſhewn in *plate* 2, *fig.* 5. The upper end of this wire has a button affixed to it to turn by hand, and the part immediately under it is formed into a ſcrew, which works in a bridge fixed acroſs the cup, ſo that by turning the ſcrew, you may either raiſe or depreſs the wire, and thereby regulate the quantity of water to be admitted, or entirely exclude it. The joints of the Water-pipe at C, and at the top of the Capital, are made conical for the greater facility of rendering them tight, by anointing them with a ſmall quantity of the china clay or other lute hereafter deſcribed; which is likewiſe to be applied to the joint where the *Conducting-pipe* F, enters the ſide branch of the Capital.

The Alembic above deſcribed, may be uſed for producing any of the artificial airs, and ſeems the beſt veſſel for making that from Zinc. At the time this deſcription was firſt publiſhed, it was thought that it would have

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proved the moſt convenient for all purpoſes, but experience has ſince ſhewn the contrary.

The *Fire-tube*, ſuch as repreſented in plate 1, fig. 3, when of equal contents with the Alembic, expoſes a greater ſurface to the action of the fire, and expoſes the ſubſtances contained in it better to the operation of the ſteam produced from the water, and thus yields the airs more readily and with leſs waſte of fuel. It is therefore preferable for preparing air from charcoal, iron turnings, chalk, &c. and anſwers very well for the Oxygene air from Manganeſe.

The main tube *a, plate* 3, *fig.* 1, 2, *and* 3, is of caſt iron, open at both ends; a kneed pipe, called an *End piece, b*, is afterwards fitted to one extremity, and receives into its perpendicular part a water pipe, ſuch as that deſcribed for the Alembic. To the oppoſite extremity of the tube, another ſimilar end-piece, *c*, is fitted, the ſide branch of which is placed horizontally to receive the Conducting-pipe F, which conveys the air to the refrigeratory. The joints are made conical, ground into one another, and made tight with lute in the ſame manner as thoſe of the Alembic.

The caſt iron, of which the Alembics and Fire-tubes, with their Capitals and End-pieces are made, is certainly liable to ſome objections; but it has been preferred as being the only *ſubſtance*, yet tried, which can bear the viciſſitudes of heating and cooling, and the application of water, when red hot, without much injnry, and the only *metal*, not too coſtly, the fumes or abraſions of which produced by the action of the water and airs might not have deleterious effects. For this latter reaſon no copper is employed in any part of the apparatus.

The

The *Conducting-pipe* F, which conveys the air from the Alembic or Fire-tube to the Refrigeratory, is made of forged-iron, about 1¼ inch in diameter, tapering to the ends to fit better. The length is from three to ſix feet, as ſuits the conveniency of the operator. To aſcertain the nature of the air, a ſmall hole, ſtopped with an iron plug, is made near the refrigeratory end; by taking out the plugs and holding a lighted candle to the hole, you may in ſome degree determine when any particular kind of air begins to come over. It would make the apparatus ſtill more perfect, if a bent tube were fitted to the Conducting-pipe near this place, and the air was received, according to Dr. Prieſtley's method, in jars through water; but care muſt be taken that the pillar of water through which the air paſſes, be not greater than that in the Refrigeratory. The quality of the air might then be more accurately determined by the uſual teſts.

2. The Refrigeratory. This veſſel is made in three different ways, according to the nature of the airs to be cooled by it.

The *Circulating Refrigeratory* G, *plate* 1, *fig*. 1, is uſed for airs which require waſhing as well as cooling, to make them depoſit any extraneous matters which they would otherwiſe carry over with them. It conſiſts of two parts, as ſhewn in the plans and ſections, *plate* 2, *fig*. 2 *and* 3, the upper part is repreſented in the inverted poſition in which it is to be placed within the other. In *fig*. 2, the outer veſſel G is repreſented, furniſhed at one ſide with a funnel and pipe R, for conveying cold water to the bottom; on the oppoſite ſide are two circular apertures, with ſhort pipes and corks fitted to them;

 the

the upper ſerves to let off the heated water, and the lower to empty the veſſel. *Fig.* 3, is a plan and ſection of the inner veſſel S; it is open at bottom, but its cover is convex, and has a ſpiral channel winding along the underſide, which being likewiſe open below, the air coming from the Alembic or Fire-tube, by the pipe N, at the circumference, paſſes through the whole of it in conſtant contact with the water of the Refrigeratory, until it arrives at the pipe O, fixed near the centre, which delivers it to the Hydraulic Bellows, by means of the Communicating-pipe P. In this long circuit it is both cooled, and in a conſiderable degree waſhed and freed from any matters from which water has an attraction. In the centre of the inner or ſpiral veſſel, is a ſhort pipe open at both ends, reaching to the lower edge of the plates that form the ſpiral, and intended to ſerve as a paſſage for the hot water to riſe through by its leſſer ſpecific gravity, when cold water is introduced below by means of the funnel R, and alſo for the ſtem of the Agitator to work in. The hot water is then ſuffered to run off through the upper pipe of the outer veſſel, and thus by a frequent renewal, the water in the Refrigeratory is kept both cool and unſaturated. A notch is made in the inner veſſel at T, to receive the pipe R, and prevent its impeding the rim of that veſſel from reſting upon the bottom of the other; in which poſition, when in uſe, it is to be kept ſteady by laying lead weights upon it.

When it is wanted to free the airs more perfectly from any acid taint, the *Agitator* or *Stirrer* is to be employed. This inſtrument is made of wood, in form of an inverted T, with a ſmall winch to turn it by at the upper end of the axis or ſtem. The lower end of the axis or ſtem fits into a ſmall cup at the bottom of the Refrigeratory,

and

and the other passes through the short pipe in the centre of the inner vessel, and turns in a socket affixed to the pipe O. The agitator being gently turned round by the winch, puts the whole water in motion; thus continually exposing fresh surfaces to the air in its passage to the bellows, and when the water is mixed with the powder of quick lime it serves to keep it suspended.

Tin plates japanned have been found to be the best material for making both the inner and outer vessel.

The *Close Refrigeratory* may be used for airs which are liable to be absorbed by the contact of water, such as fixed or carbonic acid air. It consists of a cylindrical vessel, with a close diaphragm fixed a few inches from its bottom, as represented at X, *plate* 3, *fig.* 1 and 2. The conducting-pipe from the alembic opens into the space below the diaphragm, where the steam it brings with it is condensed, and the air cooled by means of cold water poured into the upper part of the vessel upon the diaphragm, which is to be renewed as it warms, by letting off the heated water through a pipe *h* made for that purpose, and pouring on fresh. By this means the air is compleatly cooled, without coming in contact with the water, and is afterwards conveyed to the hydraulic bellows through the communicating pipe P. An aperture with a short pipe *i* is left in the lower or close part of the vessel, to let off the condensed steam, and inspect the quality of the air, if at any time need be.

Should however the circulating refrigeratory be preferred for the sake of washing the air, and freeing it from some of the calcareous earth, or other extraneous matter it brings over with it, the loss of air by the ab-

 sorption

ſorption of the water will not be very conſiderable, for the water ſoon becomes ſaturated, and as it grows warm yields back great part of the air in a purer form.

The *Pipe Refrigeratory* is the moſt ſimple of all, but can only be uſed when the air produced brings no aqueous vapours over with it, and requires no waſhing. Its uſe is therefore confined to the cooling of *dry* airs, ſuch as that produced from charcoal burning in the open air. It conſiſts of a plain pipe *n* paſſing longitudinally through a trough *m* filled with water, ſuch as that delineated *plate* 3, *fig.* 5, and connecting the hydraulic bellows immediately with the furnace or pot *l*, in which the charcoal is burning.

By connecting this pipe with any cloſe veſſel, to collect the condenſed water, it may be made to anſwer all the purpoſes of the cloſe refrigeratory.

3. The Hydraulic Bellows. An outſide view of this veſſel is given in H J, *plate* 1, *fig.* 1, and *plate* 3, *fig.* 1, and an inſide view in *plate* 2, *fig.* 1. It conſiſts of an outer or fixed veſſel H, and an inner or moveable veſſel J, which moves eaſily up and down within the other, and is ſuſpended by a cord paſſing over two pullies K K, and ſuſtaining a counterpoiſe L. To avoid the incumbrance of a great weight of water, the outer veſſel H is made double, ſo that only an interſtice of about half an inch is left between its two cylinders for the veſſel J to move up and down in, and this muſt be filled with water as high as the pricked line in *plate* 2, *fig.* 1. The cup or rim W is to prevent the water from overflowing when the inner veſſel is preſſed forcibly down. The factitious air enters from the refrigeratory by

by the communicating pipe P, and paſſes along the perpendicular pipe V into the cavity of the veſſel J, which continues riſing until it is full, when the framing M will permit it to go no higher. The air is then expelled into the air-holder or bag, through the *diſcharging-pipe* Q, by lifting up the counterpoiſe L, and allowing the inner veſſel to deſcend by its own weight.

This veſſel is alſo made of tin plate japaneed. Some ſlight variations have been made in the execution of thoſe for ſale ſince the two firſt plates were engraved, but none of ſufficient importance to merit particular mention.

4. The AIR HOLDER. The ſtructure of this veſſel is ſhewn at Y, *plate* 3, *fig*. 1 and 2. It is made of tin-plate, japanned both inſide and outſide, and is cloſe at both ends; but for the conveniency of japanning the inſide, it is made in two halves, which are joined together in the middle of the veſſel, by a cement compoſed of bees'-wax and one fourth of its weight of roſin, applied hot. By warming the joint before a fire, the veſſel may at any time be taken aſunder and cleaned. Two ſhort pipes, U and Z, proceed from the ſide of the veſſel, near its top and bottom, and another pipe, *t*, paſſes through the middle of the top or cover, to which it is well ſoldered and reaches to within half an inch of the bottom.

When the lower pipe Z is corked, the upper one U remaining open, the veſſel may be filled with water through the central pipe *t*, to which, for the conveniency of pouring, a funnel *k* is fitted; by withdrawing the cork of the pipe Z, the water may again be diſcharged, the external air which enters through the pipe U

ſupplying

ſupplying its place. So that if when it is filled with water, a ſhort pipe *g*, called the *Transfer-pipe*, be inſerted and cemented into the upper pipe U of the air-holder, and into the diſcharging-pipe Q of the hydraulic-bellows, and if the lower pipe Z of the air holder be then opened and the inner cylinder of the bellows be allowed to deſcend, by lifting the counterpoiſe, it is obvious that the factitious air contained in it will be transferred into the air-holder. The pipes Z and *t* are to be well corked as ſoon as the air holder is filled, but there ſhould always be left an inch of water at the bottom of it, to impede ſtill more all communication with the external air; as ſoon as it is disjointed from the reſt of the apparatus, the pipe U ſhould likewiſe be carefully corked.

Corks are preferred to cocks for ſhutting theſe openings, both becauſe when good, and well fitted, they are perfectly air tight, and becauſe common cocks are made of a metal, the ruſt of which is very poiſonous, being a compoſition of copper, lead, tin, arſenic, and antimony, or whatever other metals the ores may happen to contain.

Oiled Silk Bags, as it has been already mentioned are convenient for removing factitious air from one room to another, and for the patient to inhale from. They may be made in the form of a common ſack, tapering at one end like a bottle, and having a conical wooden faucet fixed in the mouth, with the ſmaller end outwards, into which a ſpiggot is to be inſerted.

To free oiled ſilk from its diſagreeable ſmell, cut it into pieces of the ſize wanted for the bags, and provide a ſmooth table ſomewhat larger than the pieces of ſilk and a flat board the ſame ſize as the table. Take *char-*

coal

coal fresh burnt in an open fire until it is free from smoke extinguish it by shutting it up in a clean close vessel; and reduce it to powder. Sift this powder over the table to the thickness of a quarter of an inch or more, spread a piece of your silk upon it, and sift upon that again another layer of your charcoal dust, and thus proceed alternating the layers of silk and charcoal, until the whole of your silk is deposited; then lay your moveable board upon the top of all, and leave the whole undisturbed for four or five days. If upon removing the charcoal dust, the silk has not lost its smell entirely, repeat the process. The charcoal dust is to be swept off the silk, and the silk to be washed upon a table with a wet sponge until it is clean. The bags must then be carefully sewed up, and the seams anointed with japanner's gold size, taking care to use that kind which does not become brittle when dry. This is used in preference of drying oil, because it has not so bad a smell. Green oiled silk should be avoided, as it is stained by means of verdigris, which rots it; the yellowish silk is the best.

Dr. Beddoes says he observed the thicker oiled silk to answer better than the thinner kind; that probably oiled lined will be found to answer; that the bags, when out of use, should be hung up by a string tied to the faucet, and that they should be as little creased as possible. To this may be added, that the best way of emptying them of all the air they contain, is to lay them flat upon a table, and to pass the hand, or a round paper ruler, gently over them.

It is necessary to observe here, that although oiled silk be the best substance known for making the bags of, it is very imperfectly air-tight; and although charcoal

duſt deprives it of ſmell for the time, yet as it can only attract the odoriferous particles from the ſurface, it re-acquires ſome ſmell by keeping, but by no means equal to what it had at firſt. — The deſideratum is ſome thin flexible ſubſtance, whoſe pores can be more perfectly cloſed than thoſe of ſilk, and a varniſh without ſmell, or ſome kind of light bellows, not of the hydraulic kind.

FURNACE. Many perſons to whom this apparatus will be uſeful, being unprovided with a convenient furnace, I have endeavoured to make one of ſuch a conſtruction as to adapt it to the uſes both of the alembic and fire-tube, which has neceſſitated ſome ſlight variations from the one repreſented *plate* 1, *fig.* 1, but which are all ſhewn in *plate* 3, *fig.* 1, 2, 3.

The aſh-pit and furnace are both made of one piece, of a cylindrical form. The furnace part is lined with fire-bricks, is 14 inches diameter within, and 18 inches over all; the depth to the grate is 11 inches, and that of the aſh-pit about 7. Two circular holes, of 4½ inches diameter, are made in two oppoſite ſides of the furnace to admit the fire-tube, which when the alembic is uſed are to be ſtopped with plugs of fire-clay. Two caſt iron rings, *r r*, are ſent with the fire-tubes, which when they are uſed fit upon the ends, and ſerve to ſhut up the circular holes of the furnace as accurately as can be done. The covers drawn in *plate* 1 are not found to be neceſſary.

A *ſmaller* furnace has likewiſe been made for a ſmaller apparatus, 9 inches diameter within the brick lining, and 9 inches deep to the grate. The fire-tubes for this are only 3 inches diameter without.

Thoſe

Those who wish occasionally to convert these furnaces into distilling furnaces, may have a fire-door *d* fitted to one of the side holes, a chimney-pipe *p* to the other, and a cast iron pot for containing sand, adapted to the mouth of the furnace; *see plate* 3, *fig*. 4; but none of these are necessary for the particular application of it to this apparatus.

Both furnaces have a door *f* to shut up the ash-pit, and at one side a sliding damper *s*, to regulate the quantity of air admitted, for when the corks are good, and the gates clear from ashes, the fire might become too strong if the fire door were to be left open. No chimney is used in the operations for producing airs, because a sufficient and a better regulated heat is produced without one; a flat plate, however, is useful to cover the furnace when the operation is over, which when the door of the ash-pit and the air-hole are shut, will soon extinguish the fire.

DIMENTIONS of the APPARATUS. The apparatus is made of *two sizes*. The hydraulic bellows of the *larger*, is 12 inches diameter, and the moveable vessel J rises about 15 inches, so that each inch in height contains 113 cubic inches, and the whole bellows 1695 cubic inches, or rather less than a cubic foot. The bellows of the *smaller* apparatus are about one third of the contents of the larger, being 8½ inches diameter, and rising 13 inches, so that each inch in height contains 57 cubic inches, and the whole of the bellows consequently 570, or about one third of a cubic foot.

The Air-holders are also made of two sizes, the larger containing a cubic foot, and the smaller half a cubic foot;

foot; which dimensions have been fixed upon as convenient for carriage when filled with air, and capable of being lifted by one person when full of water, which would not be the case if the contents were more than a cubic foot. The small air-holders will, on account of their reduced contents, be chiefly useful for conveying *Fixed air*, which should be sent out in such quantities only as are likely to be used at once. For if water be poured into an air-holder to expel part of the fixed air, and the air-holder be afterwards corked up and laid by, great part of the remaining air will be absorbed by the water.

The large Fire-tubes are three inches in diameter within, and have 14 inches in length exposed to the action of the fire; the Alembic, when filled to the neck or cylindrical part, is about equal to them in its contents. The small fire-tubes are 2¼ inches diameter within, and have 9 inches exposed to the action of the fire, consequently the contents of the larger tubes is to that of the smaller as 54 to 126, but the quantities of air which will be produced from them respectively, will not follow that ratio, because the heat will be more readily communicated to the centre of the matter contained in the small tubes, than it will to that of the large ones. Their respective actual performances have not been compared.

The larger apparatus is particularly useful where considerable quantities of air are required, especially for carbonic acid air from chalk or marble, or oxygene air from manganese, where it is of some consequence to be able to operate upon a large quantity of materials at once.

For

For the uſe of private individuals, or for experiments, the ſmaller apparatus will be found large enough; but if any quantity of air is wanted to be produced, and the operator is not too much confined for room, it will be adviſeable to combine the larger bellows and refrigeratory with the ſmaller furnace, to avoid the trouble of too frequently emptying the bellows, and to enable the operator to retain a reſerve of air within them.

STOOLS. Before attempting to uſe the apparatus, ſtools ſhould be provided for the different parts to ſtand upon. They are beſt made with round tops, and for the *large apparatus* ſhould be 16 inches diameter, and about 1½ inch thick, of elm or oak board, with three plain feet. The following heights are taken from the ſtools to the ground.

Stool	for the Refrigeratory -	18 inches.
Ditto	Hydraulic bellows -	24
Ditto	Air-holder, allowing an inch for the thickneſs of the tub it ſtands in. - - -	8½

When the fire tubes are uſed, the ſame ſtools as above will ſerve, only an additional one of 14½ inches high muſt be provided to place the furnace upon. This may be made of iron, but the heat is not there ſufficient to burn it, even if of wood.

The *ſmall apparatus* is adapted ſolely to the uſe of fire-tubes, and the following ſtools of one foot diameter will be neceſſary in uſing it:

Stool for the furnace to ſtand upon	12 inches high.
Ditto for Refrigeratory - -	17 ditto.

Ditto

Ditto for Hydraulic bellows -	23 inches.
Ditto for *large* Air-holder (allowing one inch for the thickness of the tub) - - - - - -	7 ditto

These stools are required to be so high on account of the air-holder, which would not otherwise have room to empty its water into a moderate sized tub. The elevation of the apparatus will be found a convenience to the operator.

If the smaller furnace be adapted to the larger apparatus, the heights of the stools will be as above, excepting that of the refrigeratory, which must be reduced to 16 inches; but in that case the stools of course must be of the diameter mentioned for the larger apparatus.

A stool that can be raised and depressed at pleasure, will be found convenient for placing the apparatus upon that is intended to receive air under water See p. 187.

GENERAL DIRECTIONS

FOR

THE USE OF THE APPARATUS.

AS it has been already mentioned that the fire-tubes are more convenient for general purpoſes than the alembics, it may be proper to deſcribe their uſe firſt.

FIRE-TUBES. Thruſt the plug ſent with the apparatus into one end of the tube, and holding it perpendicularly reſting upon that end, put into it what quantity you pleaſe of the material to be acted upon, taking care that the whole lie within the wide part. Lay the tube upon its ſide, take out the plug, anoint the end piece, which correſponds to the conducting-pipe, with the *Fire-lute* hereafter deſcribed, and (having firſt put one of the caſt iron rings upon that end of the tube) inſert it into the tube, turn it round a little, preſſing it in at the ſame time, and then give it a gentle blow with a piece of wood, to force out the ſuperfluous lute. Paſs the fire-tube thro' the two holes made in the furnace to receive it, and put the remaining iron ring upon the other end of it ſo as fill the hole on that ſide. Anoint the conical end of the conducting-pipe with lute, and thruſt it into the end piece above-mentioned, letting it incline about an inch towards the refrigeratory, into the receiving-pipe N of which the other end muſt be inſerted, being previouſly anointed with the *Cold Lute* hereafter deſcribed. Join the pipe G of the refrigeratory with the communicating pipe P of the hydraulic bellows, uſing the above lute for the joints. Theſe being adjuſted, anoint the other

end

end piece of the fire-tube with fire-lute, and fix it in its place, so that the water-pipe C D may be perpendicular. Lute also the joint of the water-pipe, and fix it in its place. Fill the cup D with water, having first screwed down the wire E, that no water can pass into the fire-tube.

As water is not absolutely essential for the production of oxygene from manganese, you may in that process insert the iron plug, properly anointed with fire lute, into the tube, in lieu of the end piece above-mentioned.

You may now proceed to light the fire.* — Lay the lead weights upon the inner vessel of the refrigeratory, and fill it with water, as also the outer vessel of the hydraulic bellows up to the dotted line shewn in plate 2, fig. 1, but no higher, otherwise the water will run down the perpendicular pipe V. Press down the inner vessel J of the bellows to empty it of air, cork the discharging pipe Q, and hang on the balance weight L†.

As soon as the lute of the joints which are exposed to the action of the fire is dry and hot, apply to them some of the *Fat-Lute* hereafter described, and to prevent its running off, strew some dry-slacked lime over them. This fat-lute will prevent the joints from cracking, but care must be taken that none of it get into the inside of the fire-tube, as it would give a bad smell to the air.

* The directions here given are for the *Circulating* Refrigeratory, as being most commonly used; those for the *Close* Refrigeratory will be found under the article Fixed Air; and those for the *Pipe* Refrigeratory under Phlogisticated Air.

† The Air-holder may either be fixed on now, or hereafter, as described page 202.

In

In cafes where water is neceffary for the production of the factitious air, as foon as the fire-tube is become red hot, unfcrew the wire E, fo as to admit a little water into it. The air will immediately pafs through the conducting-pipe to the refrigeratory, and gliding along its fpiral in contact with the water, will arrive at the bellows through the pipe P, wafhed and cooled. It is beft to admit no more water into the fire-tube than enters into the compofition of the airs, or is neceffary for their expulfion, as you will thus obtain them apparently more condenfed and powerful than when a fuperfluous quantity of water is admitted The latter circumftance may be known by the pipe at N becoming too hot for the finger to bear.

Care fhould be taken to renew the water from time to time in the refrigeratory, and to keep the agitator conftantly in a gentle motion if the production of the air is quick, but in cafes where the production of air is not very rapid, it will be fufficiently wafhed and cooled without ufing the agitator. In proceffes where you wifh the fixed air to be abforbed that may accompany the other factitious airs, it will be found neceffary to fill the refrigeratory with lime water, or ftill better, to add powdered quick lime to the water contained in it. The inner veffel J of the hydraulic bellows will rife gradually as the factitious air enters, but when it is full, or nearly fo, it is proper to transfer the air into the air-holder, which for that purpofe muft be placed upon a fmall ftool in a fhallow tub, and filled with water through the central pipe, in the manner already directed. Connect the air holder to the bellows by means of the transfer-pipe g, and lute the joints. Then take out the cork from the lower pipe Z, and the counterpoife of the bellows being

being lifted up, the factitious air will paſs into the air-holder, and the water be emptied into the tub. The iſſuing of the water may be rendered ſlower at pleaſure, by holding the end of the cork aginſt the opening of Z, which ſhould be re-corked as ſoon as the air-holder is full, or the bellows completely emptied of air. The air-holder is then to be removed, and all the pipes to be well corked.

It ſhould be kept in a cool place until the air is wanted, which may be transferred into one of the oiled bags as follows :—Fix the faucet, or mouth piece of the bag, lapped round with ſome wet linen rag, tied with a thread, into the inner pipe U of the air-holder, having previouſly ſqueezed all the common air out of the bag, in the manner directed page 193. If you want a quart, gallon, or other meaſure of factitious air, pour that quantity of water into the air holder, by means of the funnel *k* through the central pipe (which reaching within half an inch of the bottom, precludes the air from eſcaping, and exactly that meaſure of the incloſed air will iſſue out into the bag.* Then recork your air-holder, if not exhauſted of air, apply at the ſame time your thumb on the outſide of the bag, and preſſing it againſt the inner orifice of the faucet, to prevent the exit of the air until you can inſert the ſpiggot, which ſhould be previouſly wetted.

The quantity of atmoſpheric air wanted to be mixed with the factitious air, ſhould be thrown into theſe bags by

*It has been already remarked, that the factitious air may be tranſferred immediately from the hydraulic bellows into the bags, by inſerting the faucet, lapped round with a linen rag, into the diſcharging pipe Q, and ſuffering the inner veſſel of the bellows to deſcend, until as much air as is required enters the bag, which you may know by marking the quantity of the deſcent of the bellows.

by a pair of common bellows, the nozzle of which will admit the faucet of the bag, or by an hydraulic bellows appropriated to that purpofe, and not by that which receives and meafures the factitious airs, which will in general be otherwife employed. The fmaller fized bellows will be found fufficiently large for this purpofe. When both the airs are included in the bag, it fhould be repeatedly turned up and down, in order that they may be perfectly mixed.

Some gentlemen prefer an hydraulic bellows made to hold three or four cubic feet of air, to the bags for breathing out of; but fuch an apparatus cannot fail of being cumberfome in many cafes, and in all will be troublefome to remove, efpecially when filled with air.

Should the factitious air contained in the air-holder, require to be more thoroughly freed from fixed air or acid fumes, than has been done before; it may be effected by putting fome dry flacked lime down the central pipe, pouring a fmall quantity of water upon it, and agitating the veffel brifkly; but fo much atmofpheric air will enter on uncorking the pipe as there was fixed air abforbed.

Air Magazine. Some perfons may wifh to preferve in readinefs larger quantities of air than can conveniently be kept in air-holders. The moft readily conftructed veffel to anfwer this purpofe, would be a common cafk or hogfhead, open below, and fufpended over another larger cafk, filled with water, by a cord going over pullies, and a counterpoife, in the fame manner as the hydraulic bellows. The air might be admitted and taken out by means of a flexible pipe and a cock attached to and communicating with the upper end of

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the ſuſpended caſk; the latter veſſel being rendered air-tight by ſhaving it ſmooth both inſide and out, and filling up its pores with bees wax, applied when the caſk has been made very hot by a fire of ſtraw or ſhavings. The wax ſhould continue to be applied until the pores will receive no more, and then the ſuperfluity be wiped off. Oiled paint would give a poiſonous impregnation to the water, and a mixture of roſin gives a bad ſmell.

For inflammable and dephlogiſticated airs, the water over which they are kept may be impregnated with lime, which will prevent the putrefaction of the water, and will alſo ſerve to abſorb the fixed air. Fixed air itſelf cannot long be preſerved in this way, even when there is no lime in the water. Something of the ſame nature with the air-holder, ſeems moſt proper for this air, as the ſmall quantity of water included with the air, would ſoon be ſaturated; and for the ſame reaſon, the air-holder applied to this uſe, ſhould not be large, otherwiſe the water employed to expel part of the air, might abſorb the remainder.

Alembic, or Fire-pot. When you have put into this veſſel the proper quantity of materials to produce the factitious air, force a piece of iron down through them to make way for the water-pipe, then lute the joint of the capital B, and fix it in its place. Lute and put in the lower part of the water-pipe C; ſet the pot on its pedeſtal in the middle of the furnace, and connect together the remaining parts of the apparatus, as has been deſcribed when the fire-tubes are uſed.

In letting in the water and regulating the whole of the apparatus, proceed exactly in the manner related above.

Lutes, or Cements. *Fire-lute.* To join together the joints exposed to the action of the fire, viz. the end pieces and water-pipe with the fire-tube, the capital with the alembic and the conducting-pipe to either of them, the proper lute is the Cornish porcelaine clay, or slacked and finely sifted lime, mixed to the thickness of paint, with a solution of two ounces of borax in a pint of hot water.

Cold lute. For the other joints, a paste of dough made of about equal parts of wheat flour and porcelaine clay, or common whiting, which, for greater security, may when the joint is luted, be wrapped round with a rag. A slip of oiled silk does very well without any lute.

Fat lute. Is made of finely sifted slacked lime and drying linseed oil, wrought into a pretty stiff paste, and applied to the hot joints with a small trowel.

Fuel. The proper fuel is good coaks or cinders of pit coal, which ought not to be of the heavy sort, nor too small, as in either case you would have a dull fire. The charcoal of wood would answer very well, but it is expensive, and the consumption would be considerable. A fire of pit-coal not coaked, is irregular and unmanageable. Care must be taken to have your coaks well dried; and the first time you use the furnace, you will do well before you operate, to warm and dry it with a fire of coaks, to chase off any moisture the bricks may have imbibed, otherwise your fire will be long in lighting.

GENERAL CAUTIONS.

EACH time before you uſe the apparatus, it ſhould be waſhed with cold water, to free it from any effluvia it may retain from the laſt operation. The ſame fire-tube or pot ought not to be uſed for producing different airs; and for this reaſon, it will be proper to keep one appropriated to the making of each. Indeed, ſhould ever an eſtabliſhment be formed for making large quantities of the different kinds of air, it will be certainly adviſeable to have an entire apparatus appropriated to the making of each kind.

No bituminous or oily ſubſtances ſhould be put into the pots or tubes, for the making of inflammable airs, or any other purpoſe. Nor ſhould any ſubſtance likely to yield any of the mineral acids, be uſed in the apparatus, as the fumes would deſtroy both the conducting-pipe and the refrigeratory. The ſame objections lie againſt the volatile alkali, and to putting any alkali into the water of the refrigeratory; but as far as has been obſerved, lime water does not hurt the varniſh.

The proceſs for obtaining the inflammable airs, ſhould not be conducted by candle-light, otherwiſe the approach of the candle to the ſtream of air may occaſion dangerous exploſions. For the ſame reaſon, when any patient is inhaling this air by candle-light, the candle ſhould be kept as diſtant as poſſible.

In all caſes, wherein the powdery matter, which the air brings over in the form of ſmoke, is not intended to be taken into the lungs, the air ſhould be kept twelve hours at leaſt before it is uſed, that it may make its depoſit.

DIRECTIONS

DIRECTIONS

FOR

PROCURING THE AIRS.

THE directions here given are not intended to comprise all the methods of procuring each air, but merely those which have been found the cheapest and most easily practised. For the history of Factitious Airs, their chemical qualities, and the means of judging of their purity, the reader is referred to the last edition of *Dr. Priestly's Experiments, in 3 vols. 8vo.* to *Lavoisier's Elements of Chemistry*, and for a concise general view of the subject, to *Nicholson's First Principles of Chemistry.*

I. Dephlogisticated, or Oxygene Air. This air is best obtained from manganese, by mere heat. The methods of obtaining it from nitre, from spirit of nitre, or from manganese, by means of vitriolic acid are objectionable, because some acid always accompanies it in these cases, from which the air is difficultly freed, and this apparatus would suffer from corrosion, unless very troublesome means were employed to purify the air before it arrived at the refrigeratory.

Manganese, for this purpose, should be free from calcareous earth and noxious minerals. A very good kind is found near Exeter, which seems to possess these requisites. The presence of calcareous earth may at any time be detected, by pouring diluted nitrous acid upon the powdered manganese; for, if it contain any, there

there will be a continued effervefcence, which otherwife would not take place.

The manganefe to be put into the fire-tube or pot, muft be reduced to a coarfe powder, all the joints muft be properly prepared, and every part of the apparatus fixed in its place, as has been directed; the opening for the water-pipe is to be ftopped with an iron plug, or with the water-pipe itfelf, having fcrewed down the wire fo as to admit no water; but fome water may be put into the cup by way of precaution, merely to prevent the efcape of air, if the conical wire fhould not be tight. The fire is then to be lighted, and fuffered to burn gently until the air begins to come, when it may be gradually augmented until the air ceafes to be produced.

Water is not abfolutely neceffary in this procefs, for although it feems rather to accelerate the production of the air, it does not augment the quantity produced. It is therefore as well to make ufe of the iron plug to ftop up one end of the fire tube, inftead of the end-piece, and water-pipe as above directed.

A pound of the hard part of *Exeter* manganefe, yields about 1400 cubic inches of air, highly dephlogifticated, and a very fmall portion of fixed air, will be abforbed by the water in the refrigeratory. The foft or clayey part feems not to yield fo much, but what it does yield is equally pure.

Some manganefe yields its air at fo low a heat, that it is neceffary to have every joint tight, and all the apparatus ready before the fire is lighted. If the manganefe happen to be wet, it will be a confiderable time before any air comes over.

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The fire-tube of the large furnace holds about 6lb. of manganese, which will yield about five cubic feet of air; those of the small furnace contain nearly 3lb. and yield about two and a half cubic feet of air.

Mendip manganese contains much calcareous earth, and consequently yields fixed air combined with phlogisticated or azotic air, both in the beginning and end of the process. A pound yields only about 500 or 600 cubic inches of impure dephlogisticated air, of which about one third part is absorbed by washing it with lime and water. To ascertain the point at which it begins to yield dephlogisticated air, take out the plug in the conducting pipe, from time to time, and hold a lighted candle near the hole; from the brightness of the flame you will easily discover when the oxygene begins to come and when it ceases, and thus you may be able to keep it separate from other airs.

Objections have been started against the air from manganese, the salubrity of which it is said has not been constituted by experiment, and even if it should be found innocent when taken into the stomach, that as an earthy powder it may have bad effects upon the lungs. To this it is answered, that if the air stand a few hours, it will deposit the merely suspended earth, and what it retains will be in a state of solution in the air, and of too fine a texture to prove hurtful, as soft powders are found not to injure that organ. It is farther answered, that Dr. Beddoes and others have constantly given the air from manganese, without perceiving any bad effects attributable to that cause; and lastly, that no other means of obtaining this air equally unexceptionable, have yet been pointed out. For it seems undeniable, that the fumes of nitrous acid, or of the sulphuric, must prove much

much more deleterious than the powder of manganeſe, and they ſeem almoſt *inſeparable* from the airs obtained from nitrous and vitriolic ſalts.

II. Phlogisticated, Azotic, or Nitrogene Air. No proceſs for producing this air unmixed with other airs, by means of mere heat, has yet been diſcovered, but it may be readily enough obtained mixed with fixed air.

Plate 3, *fig.* 5, repreſents a chafing-diſh, nine inches high and ſix inches diameter, communicating through the medium of the pipe refrigeratory *n m*, with an hydraulic bellows at *n*. The chafing-diſh is to be completely filled, or rather heaped, with the charcoal of ſome of the ſofter woods, and in preference to that of the twigs or ſmall branches, previouſly kindled and made red hot in a common chafing-diſh. The trough of the refrigeratory is to be filled with cold water, and the end *n* to be connected with the pipe P of the hydrualic bellows. Theſe muſt be ſuffered to riſe very ſlowly, ſay thoſe of the larger apparatus in five or ſix minutes. The air which has ſerved to animate the fire, and has there been deprived of its oxgene, will paſs through the ſide pipe of the chafing-diſh and the pipe of the refrigeratory into the bellows; and when the operation has been properly performed, it will be found to contain no uncombined oxygene air.

If the uſe to which this air is to be applied, requires it to be freed from the fixed air it contains, that may eaſily be effected, by agitating it in the air-holder with a mixture of lime and water, or with a ſufficient quantity of pure water.

III. Fixed,

III. Fixed, or Carbonic Acid Air. Take as much good chalk as your fire-tube or pot will hold, break it into bits of about a quarter of an inch cube, and ſoak or boil it in a large quantity of water, to extract any ſaline matter it may contain. Put it into the fire-tube or pot, and prepare your apparatus, as has been already directed, making uſe of the cloſe refrigeratory, as repreſented in *plate* 3, *fig.* 1; unleſs, for particular purpoſes you wiſh to have your air waſhed, and do not value the loſs of a ſmall quantity; in which caſe you may make uſe of the circulating refrigeratory, as has been ſaid before.

When your fire has burnt up, and your fire-tube or pot is become fully red-hot, admit water ſlowly by the water-pipe, and the fixed air will immediately iſſue and paſs to the bellows.

If you make uſe of the cloſe refrigeratory, you muſt renew the cold water in the upper part from time to time, that the air below the diaphragm may be properly cooled, and any ſteam it brings over with it may be condenſed.

Chalk is recommended in preference to marble, as it gives out its air at a lower heat.

The fire-tube of the ſmaller apparatus, when filled full, which it always ſhould be, as otherwiſe the ſteam may paſs over without acting upon it, will hold about 1½lb. of chalk, which will yield about four cubic feet of very ſtrong fixed air, mixed with ſome inflammable air from the iron tube.

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The fixed air thus obtained, carries with it some of the chalk in a state of suspension, which it will deposit by standing a few hours in the air-holder, or other convenient vessel.

IV. INFLAMMABLE, OR HYDROGENE AIRS. First, *Zincic Inflammable Air.* The purest, or at least the lightest species of this air is produced from zinc. The metal being broken or granulated, a few pounds of it is to be put into the alembic, and the apparatus being adjusted with the circulating refrigeratory, &c. as before directed, it is to be brought to a strong red heat, and water to be admitted very slowly. It seems impossible to avoid the circumstance of a considerable quantity of steam accompanying the air, which renders it necessary to renew frequently the water in the refrigeratory.

This air carries with it a large quantity of the flowers of zinc in suspension, which it deposits by standing at rest; it probably also contains another quantity in a state of solution, which seems to form a part of its substance, and on which some of its virtues may depend.

If the air is wanted to be still more highly charged with the flowers of zinc, it would be proper to make use of the close refrigeratory.

When the fire-tubes are used in this process, part of the zinc sublimes in a metallic state, and is apt to choak the end pieces; the alembic is therefore recommended in preference, as being free from that inconvenience. Only a small quantity should be put in at a time, as the water could not force its way through any depth of the melted metal.

As

As zinc does not produce very large quantities of inflammable air, and is more expenſive than iron, Dr. Beddoes adviſes to put in only a few ounces of zinc, and to fill up the fire-tube with hammered iron turnings. The air produced in this way will probable carry with it both iron and zinc.

2. *Martial Inflammable Air*, or hydrogene gas from iron, is the next in ſpecific gravity to the inflammable air from zinc, and likewiſe carries with it ſome of the metal from which it is formed. It has alſo more of an hepatic ſmell than the zinzic air.

To produce it, the fire-tube or pot is to be filled with the turnings or chippings of hammered iron, which may be had from the whiteſmiths. Caſt iron turnings or borings give much more of the hepatic ſmell, and alſo contain more charcoal or carbone. Before the turnings are put into the fire tube or pot, they ſhould be heated red hot in a crucible, and quenched in water, to free them from oil, or other combuſtibles.

The apparatus is then to be adjuſted as in the former caſes; and when the fire-tube or pot is red hot, water is to be gradually admitted, which will readily extricate the air.

The fire-tubes of the ſmall apparatus hold about two pounds of hammered iron turnings, which yield a large quantity of air.

When the turnings uſed for this purpoſe have not been exhauſted, if they are plunged red hot into water, they

they will throw off the ſcale or calcined iron, and when heated again, will preſent freſh ſurfaces to the action of the water.

3. *Heavy Inflammable Air, Carbonated Hydrogene, or Hydro-Carbonate.* Take charcoal made of the twigs of the ſofter woods, ſuch as willow, poplar, hazle, birch, or ſycamore, avoiding ſuch as have reſinous or aſtringent juices. Prepare the charcoal by heating it to full ignition in an open fire, and quenching it in clean water; or by filling a crucible with it, covering it with clean ſand, and expoſing it to a ſtrong heat in an air furnace; and then ſuffering it to cool. In either of theſe caſes, it will be found free from any bituminous matter, which might contaminate the air, as generally happens with common charcoal.

The fire-tube or pot is to be heated red hot, and water admitted, as directed in the other caſes. It has been obſerved by Dr. Prieſtley, and confirmed by my experience, that where much water paſſes in the form of ſteam, there is alſo much fixed air formed; but leſs, or none, when the water is admitted ſo ſparingly that no ſteam reaches the refrigeratory; and in the latter caſe it ſeemed to me that the air was more potent, that is, it was more ſubject to cauſe vertigo, &c.

This air having generally a diſagreeable ſmell, an experiment was made with a view of producing it more free from that quality. Half an ounce of charcoal, finely powdered, was intimately mixed with half a pound of ſlaked, but cauſtic lime, quite dry. This mixture was put into the fire-tube, and without the addition of water, produced about a cubic foot of inflammable air, with much

much lefs fmell than ufual, and in the opinion of my operator, not fo likely to caufe vertigo.

The production of the carbonic inflammable air by the addition of water is very rapid, as even the fmall fire-tubes will produce a cubic foot in five or fix minutes. With the lime the production is flow.

4. *Animal Inflammable Air* is produced by putting any animal fubftance into the fire-tube or pot, and expelling the air by mere heat; wool, hair, and feathers, produce it in larger quantities than the mufcular part of animals. In all cafes the air thus obtained is extremely fœtid and deleterious, caufing vertigo and permanent naufea. It brings over large quantities of volatile alkali, which hurts or deftroys the varnifh of the apparatus. If it fhould be thought that it would prove ufeful in any difeafes, it is probable that the air obtained from the charcoal of animal fubftances may be as falutary, and lefs naufeous, than that obtained from them in their frefh ftate. It is therefore propofed to reduce wool, feathers, or hair to charcoal, in a clofe veffel expofed to a ftrong heat; to put this charcoal into the fire-tube, and to obtain the air by the addition of water; by which procefs it is thought it will be obtained more free from the fœtor, and from the volatile alkali.

MISCELLANEOUS OBSERVATIONS.

IN every operation in which water is requiſite to the production of the airs, the fire-tube ſhould be filled compleatly with the bruiſed material, otherwiſe the ſteam would paſs over the ſubſtance without acting upon it. This precaution alſo renders the production of the air more rapid and certain, and at the ſame time leſſens the proportionate produce of inflammable air from the fire-tube, which, eſpecially with a new tube, might otherwiſe form a conſiderable part of the whole.

A *Coating* for the inſide of the fire-tubes which would prevent the action of the ſteam, or other ſubſtances on the tube, is deſirable, but none which completely anſwers that purpoſe has hitherto occurred. The beſt has been the lute of China clay and ſolution of borax. To apply this, the tube ſhould be made as warm as the hands can bear, and one end being ſtopped up by the plug, the lute ready mixed up to the conſiſtency of cream, is to be poured into the tube. The other opening is then to be ſtopped, the tube agitated in all directions for a ſhort time, and the lute, which does not adhere, ſuddenly poured out; after which, the tube muſt be rolled upon a table until the heat has evaporated the water of the lute. It is probable that this lute might be improved by an addition of calcined flints ground to fine powder, ſuch as are uſed in the Staffordſhire potteries.

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When the inflammable air is prepared by means of zinc, the pot ſhould be coated in this manner, to prevent the zinc, or its calx, from adhering to the iron, which it would otherwiſe do, and be difficultly got off.

Earthen tubes or *pots*, which would be air-tight, and would ſtand repeated heating and cooling, would be a valuable acquiſition; but conſidering every circumſtance, this ſeems hardly practicable, as the crucible compoſitions which are beſt adapted to bear the heating and cooling, are too porous to contain the airs, and generally too tender to bear the fitting in of the end-pieces.

From ſome circumſtances it appeared probable, that the matter which communicated ſmell to the inflammable airs, might alſo be the cauſe of vertigo, and other diſagreeable effects; it was therefore attempted to deprive them of ſmell. A quart bottle was filled with ſome very ill-ſcented hydro-carbonate, and an eight ounce vial, with a mixture of calcined charcoal-duſt and water. The mouths of the two were luted together with a ſtrip of bladder, and inverted; the contents of the vial fell down into the bottle, where it was well agitated with the air, the apparatus was then reverſed, and the operation repeated more than once. On opening the bottle, it was found that the air had loſt its *bad* ſmell; its odour was not entirely gone, although what it retained was not unpleaſant. However I ſoon found, by merely ſmelling at the mouth of the bottle, that it had not loſt its power of cauſing vertigo. Conceiving theſe ſmells to be cauſed by ſulphur in ſome of its forms, it was thought that a *metallic calx* might produce the ſame effects. The powder of calcined mangane ſe was ſubſtituted for the charcoal in another experiment, and apparently produ-

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ced a ftill more powerful effect. The procefs with charcoal was attempted upon a larger quantity of air in the air-holder, but it was found that it required confiderable quantities of charcoal-duft and of water, to produce the effect even in an imperfect manner. The experiment, however, feems worthy of repetition, as the fmell, with people of delicate nerves, will always be fome obftacle to the free ufe of the airs.

In the mean time, it is recommended to try the following method in the extrication of inflammable air from charcoal and from iron. When you charge the tube, fill it half or three quarters full with clean wafhed and calcined fand, the kind called *Calais fand* feems the moft proper, and upon this put the charcoal or iron to be operated upon, which will thus lie next to the water-pipe. The air produced muft pafs through the interftices of the red hot fand before it can arrive at the refrigeratory, and it is expected will be confiderably changed by thus coming into contact with fo much hot furface. The experiment may be varied, by fubftituting cauftic flacked lime,* or clean pounded tobacco pipes, in lieu of the fand.

Whether the Hydro Carbonate thus obtained in a purer or more inflammable ftate, would have the fame virtues as a medicine, muft be left to Phyficians to determine; I fear it would not, as it would approach near to the nature of the metallic inflammable airs, which are not fo powerful.

If the fire-tube is entirely filled with fand, and the vapour of fpirits of wine, or of ether, from a fmall retort,

* When lime is ufed, the hydrocarbonate will be defulphurated, and confiderably altered in its qualities.

are

are made to paſs through it, inflammable airs will be produced of the nature of hydro carbonate, though ſpecifially ſomewhat different.

REFERENCE *to the* PLATES.

PLATE I. *Fig.* 1, Elavation of the Large Pneumatic Apparatus, with the Alembic. *Fig.* 2, Bird's Eye View of the Furnace, with its Covers. *Fig.* 3, Section of the Fire-tube and Furnace, according to the firſt Conſtruction.

PLATE II. *Fig.* 1, Section of the inner and outer Veſſels of the Hydraulic Bellows. *Fig.* 2, Section of the outer Veſſel of the Circulating Refrigeratory. *Fig.* 3, Section and Plan of the inner Veſſel of the Circulating Refrigeratory. *Fig.* 4, Section of the Alembic and Water-pipe. *Fig.* 5, Section of the upper Part of the Water-pipe, and View of the Conical Wire.

PLATE III. *Fig.* 1, Elevation of the Large Pneumatic Apparatus, with the improved Furnace Fire-tube, Cloſe Refrigeratory, and Air-holder. *Fig.* 2, Plan of ditto. *Fig.* 3, Section of the Furnace and Fire-tube. *Fig.* 4, Section of the Small Furnace, with Sand Bath, Retort, and Chimney adapted for Diſtilling. *Fig.* 5, Section of the Pipe Refrigeratory.

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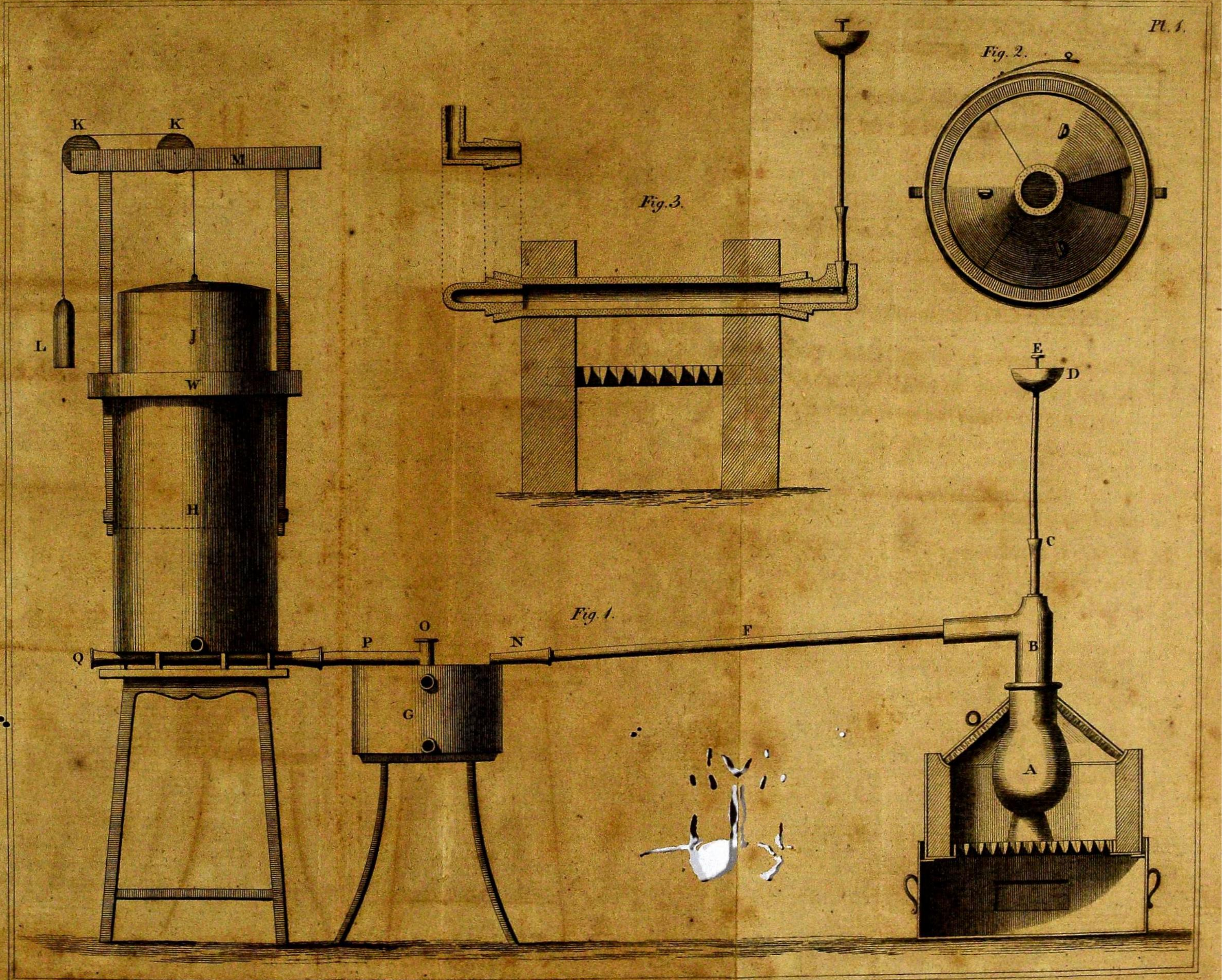

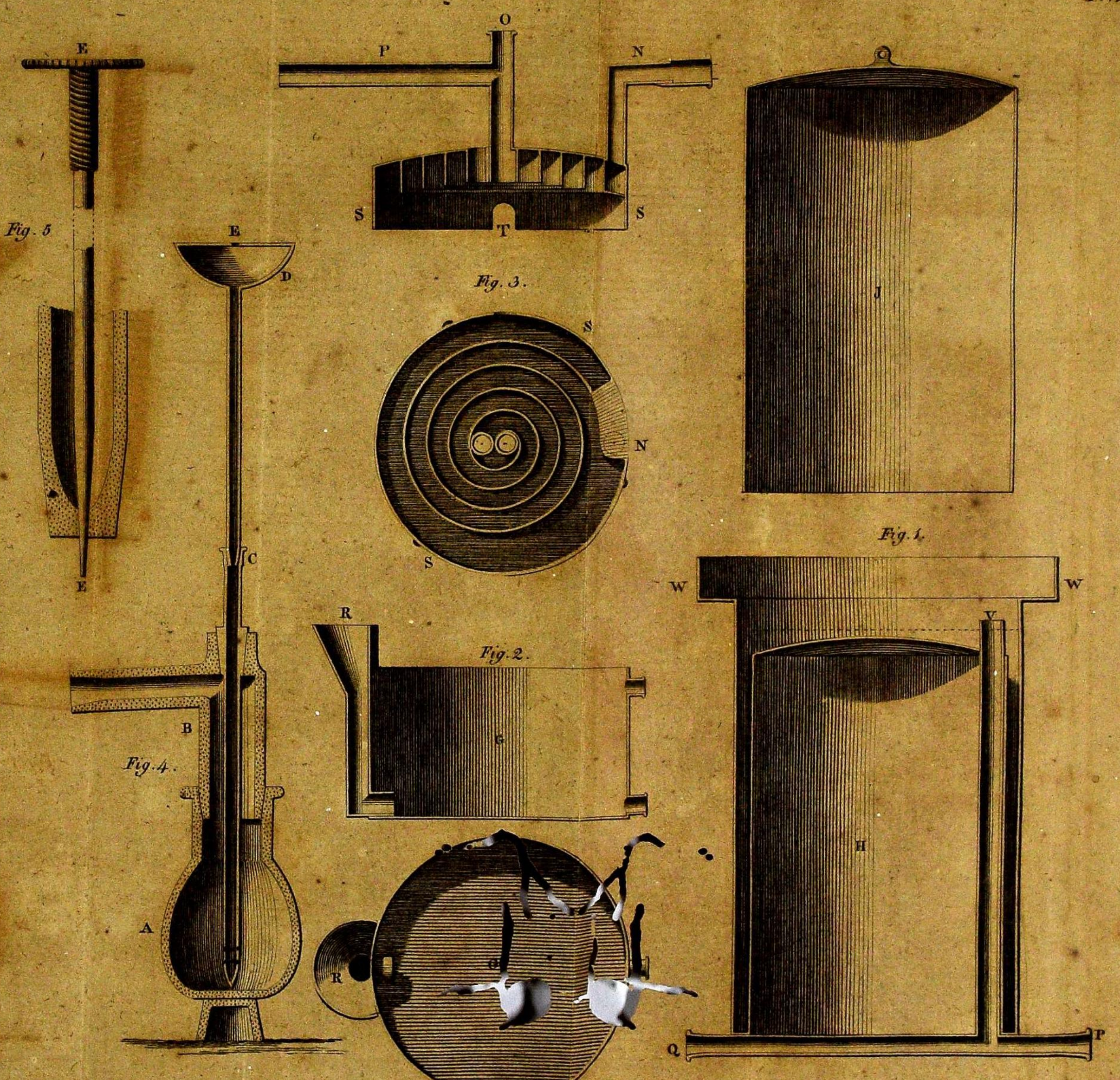
Fig. 5
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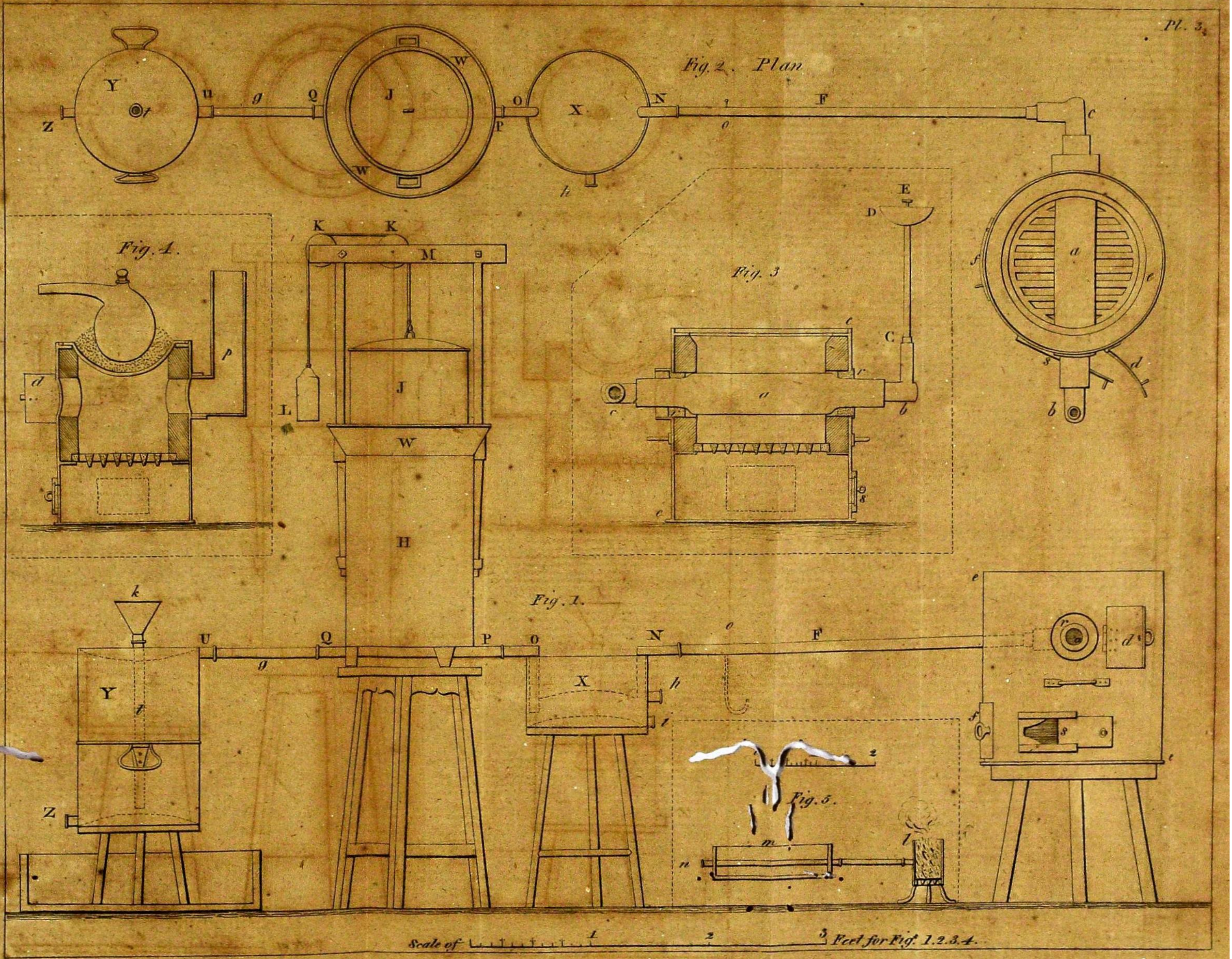
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Plate IV.

Fig. 1.

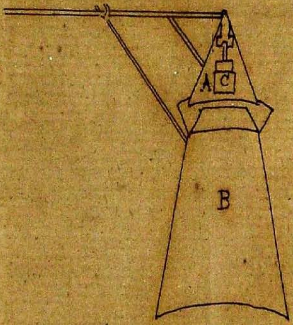


Fig. 2.

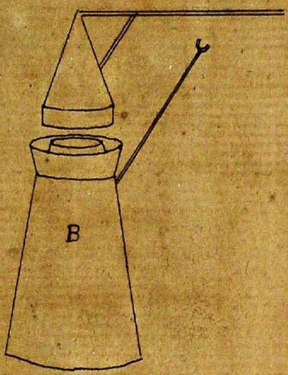


Fig. 3.

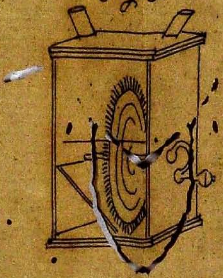
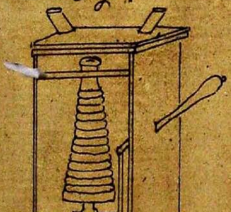


Fig. 4.



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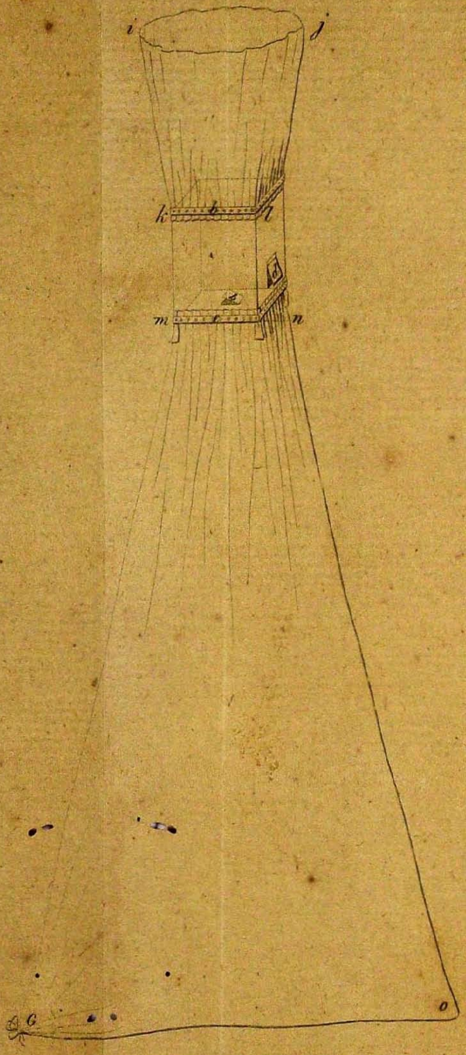

ADDENDA.

THE following letters (except that from Mr. Field) immediately refpect the fubject of the pamphlet, and I make no apology for adding them here. Mr. Field's is of great importance; and with the facts I have publifhed in my tranflation of Mr. Gimbernat's Effay on the Femoral Hernia, feems to go near to demonftrate the fuperior fafety of inoculating with diluted matter. Dr. Jenner's opinion of the nature of tubercles I know to have been formed without the knowledge of a fimilar opinion on carcinoma. It will infallibly give rife to new refearches, and if confirmed, may lead to an effectual method of cure. —— I am this moment informed that Dr. Girtanner, of Goettingen, has fucceeded in the cure of fome cafes of confumption, by giving one part of carbonic acid air in conjunction with three of atmofpheric. He employs a mouthpiece with double valves; fuch as Mr. W. Yonge projected at the commencement of this practice, and fuch as Mr. Watt has carried to great perfection: Dr. Lawrence, phyfician, at Swafham, Norfolk, informs me that he has fucceeded in fome of thofe cafes where he has ufed factitious airs. I hope to obtain an account of his experience for a fourth part of thefe Confiderations. T. B.

Kingscote-Houfe, Feb. 9.

DEAR SIR,

Your proof-fheet has juft reached me. I obferve an error, *infected* for *infefted* (8th line from the bottom, page 178.)

My hafty letter of the 29th Jan. would have been more explicit had the idea of hydatids being the caufe of tubercles in the lungs been elucidated by a comparifon with infect-irritation among vegetables. Here we fee a variety of excrefcences evidently of infect origin. It is clearly demonftrated in the oak-apple and the gall-nut; but in nothing more beautifully or familiarly than in the moffy excrefcence that fprings from the wild-rofe or the fweet-brier. Your's, &c. E. JENNER.

To Dr. Beddoes.

P. S. If from further inveftigation it fhould appear that my opinion of the firft exiftence of tuberculous confumption be juft, your mode of treating the difeafe, efpecially in its early ftages, may prove highly important; as the factitious airs you introduce into the lungs will probably be deleterious to the hydatid, before it is defended from injury by too thick an incruftation. With this view, I long ago directed patients to inhale the vapours of tar, made warm, and diluted with oil of turpentine; and, I think, with manifeft advantage. As a demonftration that turpentine is deftructive to hydatids, I have a curious fact to make public. There is only room now juft to fay, that a young man who had hydatids in his kidneys was prefently cured by the ufe of oil of turpentine. It was principally fent into the fyftem through the fkin.

DEAR SIR,

Conceiving that the following facts have a ftrong tendency to fupport your hypothefis relative to the origin of fea-fcurvy, I beg leave to lay them before you.

A very

A very reſpectable family in this neighbourhood, conſiſting of an elderly lady and her three daughters, quitted a town reſidence a few years ſince and retired into the country. At this time they enjoyed very good health. Not long after they occupied their new habitation an unpleaſant change began to appear in the conſtitution of the eldeſt of the young ladies, and ſoon after in the youngeſt. It firſt ſhewed itſelf in an averſion to exerciſe and a loſs of their accuſtomed ſpirits and vivacity. This was followed by the appearance of broad livid ſpots on the ſkin, reſembling *ecchymoſes*, which were ſurrounded by cluſters of ſmall puſtules that itched intollerably. Frequent hæmorrhages alſo took place from the noſe and gums; and one of the ladies, the ſecond ſiſter, (on whoſe ſkin no livid ſpots or puſtules had ever appeared) was twice affected with hæmorrhages from the ſtomach, ſo profuſe that they had nearly proved fatal to her. In no one of the family were the ſymptoms ſo violent, the hæmorrhage from the ſtomach excepted, as in the eldeſt. She gradually ſunk under their preſſure, and died. For ſome months previous to this event, her countenance aſſumed a bloated appearance, her legs became œdematous, and an ulcer appeared on one of the ancles. Her mental faculties were much weakened, and during the laſt fortnight of her exiſtence, ſhe lay in a ſtate of perfect inſenſibility; for the moſt part comatoſe.

It was impoſſible to perceive theſe ſymptoms without being ſtruck with their ſimilitude to thoſe of ſea-ſcurvy, but the probable exciting cauſe did not occur to me until I peruſed your publication on the ſubject,

 when

when it immediately ſuggeſted itſelf that the family were affected with the ſymptoms above related from breathing air far beneath the purity of that of the common atmoſphere. The chimney of the room where they commonly lived was ill conſtructed and without a free ventilation. I ſcarcely ever entered the apartment without being ſenſibly affected with the peculiarity of the ſmell.—It was not merely that of a ſmoaky room but ſeemed to partake alſo of the ſmell occaſioned by pouring water on hot coals. The grate made uſe of was a common Bath ſtove, in which there was pretty conſtantly a fire made of pit-coal both in ſummer and winter.

I remain, Your's, &c. E. JENNER.

To Dr. Beddoes.

Worceſter, Feb. 8th, 1796.

DEAR SIR,

Having lent your account of the good effects of diluting variolous matter, for the purpoſe of inoculation, to my friend, Mr. Field, of Eveſham; he returned it to me, with the following letter; which he has allowed me to communicate to you for publication, and which, I am well perſuaded, you will think contains information of ſufficient conſequence to intereſt practitioners and the community.

I am, &c. W. SANDFORD.

To Dr. Beddoes.

Eveſham, Jan. 9th, 1796.

DEAR SIR,

I am much obliged for the peruſal of the pamphlet herewith returned.

How

How very frequently do we obſerve things offered to the public, as new diſcoveries, which others have long been acquainted with. The firſt perſon ſhall be long in the practice of the improvement, without eſteeming it of conſequence enough to publiſh; whilſt the perſon who makes a ſimilar diſcovery, unconſcious of its being known before, preſents it to practitioners as new and important.

For upwards of twenty years I have been in the practice of inoculating with variolous matter very much diluted, even beyond what Dr. Beddoes or his correſpondents make mention of, and with a ſucceſs that has often ſurprized me. The number of patients inoculated by myſelf and pupils muſt exceed TWO THOUSAND, without the loſs of more than ONE; and I believe I may ſay with ſcarce a ſiniſter accident. — Inſtead of taking a gooſe-quill *full* of matter at a time, which is frequently done I believe, I have not, I am confident, expended more than a drop or two, for the laſt twenty years. If I have thirty or forty perſons to inoculate at the ſame time, I only moiſten the point of a lancet with the matter, and let it dry on. I always prefer the thin pellucid matter, which is to be obtained in the early ſtages of the diſorder, before maturation and perhaps a day or two after the eruption (if from inoculated patients), to that which is more concocted and purulent, becauſe I find it more infectious and becauſe it diſſolves better, and mixes more intimately with any aqueous menſtruum. I cannot aſcertain preciſely the degree of dilution in any inſtance, but I preſume it muſt in ſome have been in the proportion of 100 p. to 1.

I remember having ſome talk with my brother at Worceſter on that ſubject a good while ago, when I propoſed

propofed mixing a fingle drop of variolous pus with an ounce of warm water; whether he has confidered it or adopted the practice I know not; for myfelf I can only fay I am not an experimental man, but I doubt not from what I have obferved, that matter fo diluted would give the difeafe to as great or greater certainty than thick matter; and I have every reafon to believe, in a milder degree; for where I have one patient complaining of too large a burden, I have fifty who are not fatisfied with their number of puftules: and I have had many who have paffed through the difeafe without being able to difcover any eruption, which *I* fhould always think fortunate, if my patients or their friends would be of the fame opinion.

Though the matter I inoculate with is fo much diluted, I ufe the fmalleft quantity poffible, and fcarcely ever draw blood, yet I do not fail to infect once in many hundred times, and am therefore perfuaded, that the *abforption* of thin diluted matter is more certain, than *of that* which is thick; and the puncture I make under the cuticle being fo flight as not to produce inflammation or digeftion, the matter cannot be thrown off before abforption takes place.

The following circumftance that once occurred to me feems to prove the thin variolous matter to be more infectious than may be generally imagined. Having fent almoft all my lancets to London to be ground, and being difappointed in my expectation of receiving them back fo foon as I expected, from ufe or accident the few lancets in my poffeffion were

at

at that time unfit for bleeding, except one that had been kept with variolous matter on it for the purpose of inoculation. This lancet I was at last reduced to the necessity of bringing into use for bleeding; previous to which I washed and cleaned it so assiduously, that a lancet just ground could not possibly have appeared more clear and beautiful in its polish. Yet the next person I bled with it called a few days after complaining of a sore arm, when it was evident to me, from the appearance of the orifice, and pain in the axilla, that I had inoculated him by bleeding: and a short time rendered it certain, by the appearance of the small pox, which he had in a very favorable manner.

I remain, &c. B. FIELD.

To Mr. SANDFORD.

While the preceding pages were printing, I heard of the death of a lady, to whose carcinomatous breast carb. acid air had been previously applied. I was told that the breast had healed with prodigious rapidity; and mindful of the propriety of publishing cases where injury has occurred from factitious airs, I wrote to the surgeon who had attended. There seems no connection between the effect of the air and the patient's death: Nor did Dr. Ewart's patient suffer from the healing of her breast. Yet, when an old ulcer is healing apace, would it not be prudent to open an issue?

Newcastle, Feb. 2, 1796.

SIR,

As I only attended Mrs. R—— W———— occasionally, I cannot give you the particulars of her case

so

ſo exactly as I could wiſh. In regard to the effects of the carbonic-acid gas, it appeared to me to relieve the pain. There never was much diſcharge from the wound; before the application of the gas, it was covered with a brown ſcab, which came away, and the wound healed. There was a great number of ſmall tubercles all over the breaſt, and the lymphatic glands in the arm-pit were enlarged; theſe were *very much reduced* in ſize, and the pain leſſened. As theſe were cauſed by the abſorption of the matter, I attributed their amendment to the matter being rendered more mild from the application of the gas; an effect I have ſeen more than twenty years ago from the ſame application. I cannot attribute her death to the healing of the wound, as the other breaſt became diſeaſed afterwards, and the diſcharge from the former was always very trifling. The liver in Mrs. W———'s caſe, was evidently diſeaſed from the beginning of her complaints, and before there was any appearance of cancer in her breaſt; and, in my opinion, ſhe was more relieved from ſmall doſes of calomel, and ſteel, than any other medicines. I always thought her taking oxygene was prejudicial. Before ſhe died there appeared a tumour upon the liver, which increaſed to a large ſize; but as I had no opportunity of examining the body after death, cannot ſay any thing more. I have long been of opinion, that all *truly cancerous* complaints are preceded by ſome of the liver; but to explain my ideas on this ſubject, would lead me beyond the bounds of a letter.

I am, with much reſpect, Your's, &c. J. BENT.

To Dr. Beddoes.

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OF

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